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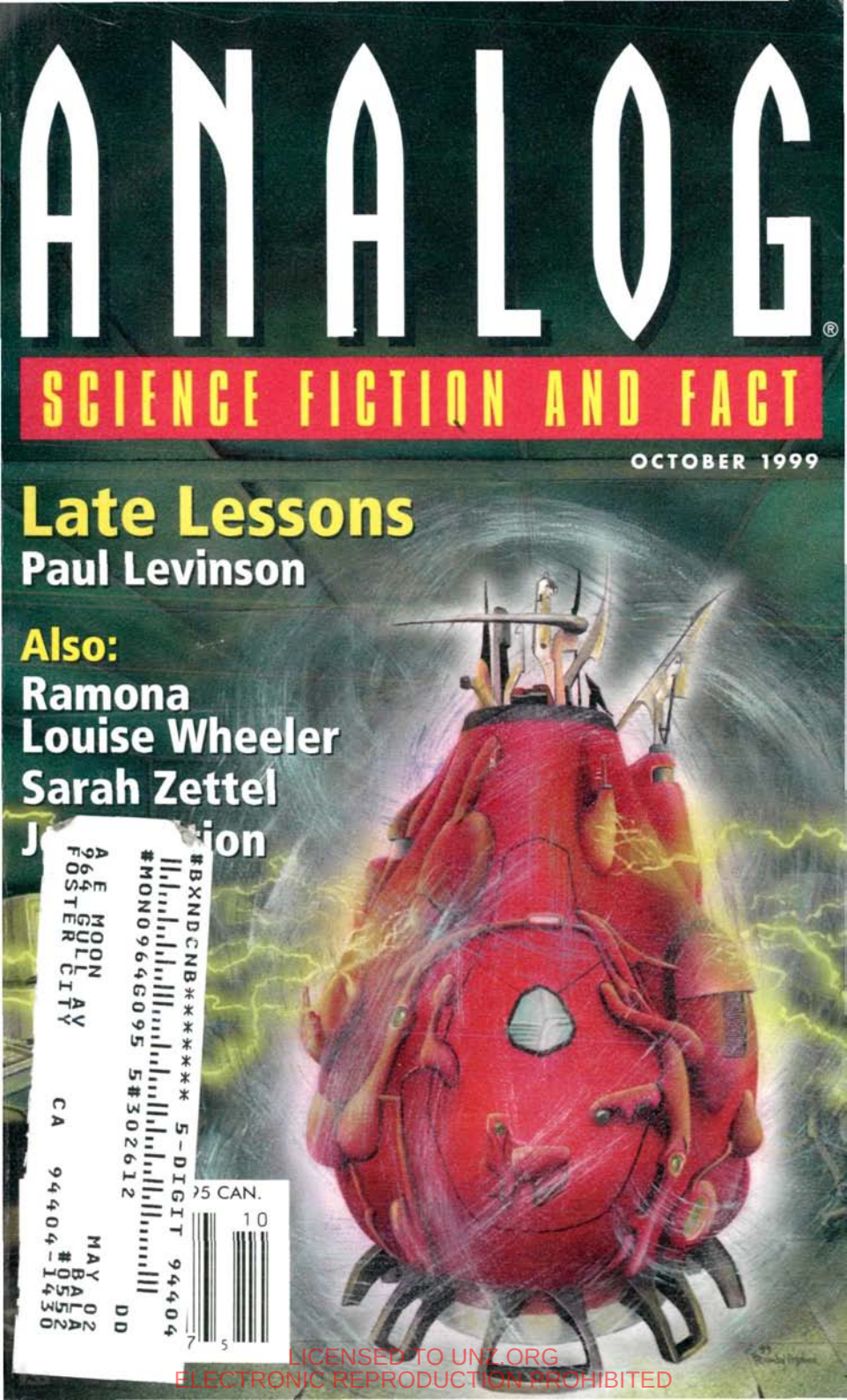

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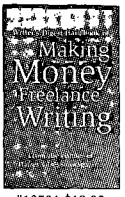

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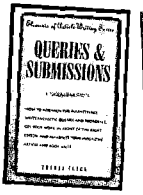

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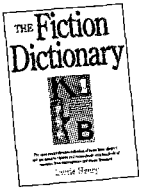

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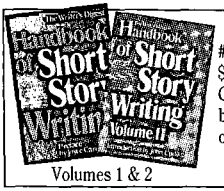

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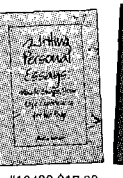

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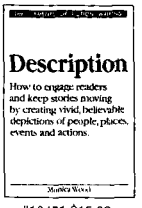
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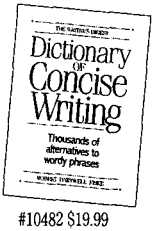

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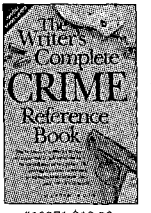

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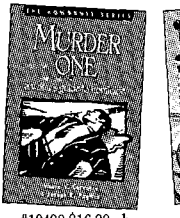

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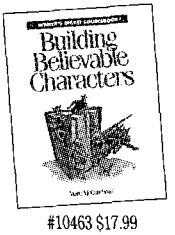

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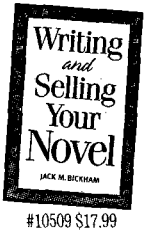

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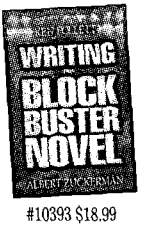

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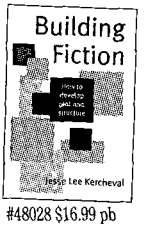

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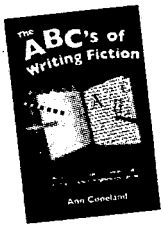

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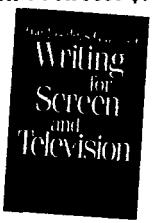

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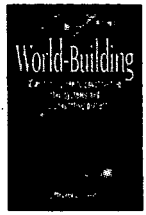

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SCIENCE FICTION AND FACT

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EDITORIAL Stanley Schmidt

INITIAL CONDITIONS

Let's try something different this month. My English teachers always told me, "Give specific examples"; but over and over I've found that when I begin an editorial with a specific example, some readers insist on thinking that that specific case is what the piece is "about." It almost never is, so this time I'm going to try an experiment. I won't name names; I won't give *any* specific examples (at least, not real ones). If you pay the slightest attention to news media, you can easily fill in plenty of them for yourself. But please *don't* accuse me of attacking any person or group. If you do, you're wrong and you're missing the point.

And the point is important. It lies at the heart of a great deal of past and present human conflict, and will no doubt continue to rear its ugly head in any future dealings our species may have with others.

The point is: *You are not responsible for what your great^n-grandparents did to mine, and I am not responsible for what my great^n-grandparents did to yours.*

I hope that seems reasonably self-evident. But a surprising number of people seem to have trouble grasping the implicit corollary: *Neither of us owes the other any "reparations" for those misdeeds of our ancestors.*

So, for example, if People A claim that a large tract of land or sum of money should be "returned" to them because People B took it from them by force or legal skulduggery, the claim makes logical and moral sense only if People A are the actual individuals who were robbed or swindled and People B are the actual individuals who robbed or swindled them. If that's not true, a judge or other authority who recognizes and enforces the claim is, in effect, robbing people who have committed no offense to "return" something to people who never had it.

Yes, I realize it's not always quite as simple and clear-cut as that makes it sound. I can recognize that there are problematical "borderline" cases, especially when the offense was recent and some of the people involved are still alive. Suppose, for example, that Mr. C embezzled some millions from Company D in March, died in April, and his crime wasn't proved until a month after the will was read and his estate distributed to his heirs.

A good ethical, and probably legal, case can then be made for Company D and the individuals who compose it to get at least some of the ill-gotten gains "back" from Mr. C's heirs, even though they didn't personally steal it. It will disappoint and inconvenience them, perhaps somewhat unjustly; but then, this is money that they did not personally earn and until recently did not have or (perhaps) expect to have. Taking it away this soon after their windfall is not entirely right, but it's not the same as taking away hard-earned life savings that they need to live on. And at least most of the folks at Company D *were* actually victimized, and therefore deserve some

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restitution, if it can be obtained without committing a greater offense against other innocent people.

But what of a situation like the one in Maya Kaathryn Bohnhoff's novel *Squatter's Rights*, which *Analog* serialized in March and April 1993? There humans have colonized the planet Velvet and been the only civilization there for decades when members of another species calling themselves the Tsong Zee show up and claim Velvet is theirs and the humans must leave. The basis of the Tsong Zee claim is that Velvet was their world of origin but they nearly destroyed it and then left it for two thousand years. Now they want it "back"—but they are not the ones who left it. They've never seen it or been there, nor has anyone they've ever known. Their ancestors left no POSTED signs advising visitors that, "We're coming back."

The only possible justification for their claim is that their culture is in some sense equivalent to a person, because only their culture has had any sort of continuity that goes back far enough to have any kind of demonstrable link to Velvet. But honoring such a claim involves dispossessing living individuals who've grown up there and quite reasonably consider it *their* home, and turning it over to strangers who've never personally had anything to do with the place.

Bohnhoff's negotiator, Rhys Llewellyn, manages to find a compromise that everybody likes pretty well, but on our real planet things have not always worked out so neatly. We all know of ethnic hostilities that go way, way back, that show little or no sign of fading away, and that stem largely from failure to recognize or understand the difference between groups and the individuals who compose them. Personally (and I don't claim to have Rhys Llewellyn's diplomatic skills), I would consider the Tsong Zee claim pretty weak, given that they had never been on Velvet and their ancestors abandoned the place many generations ago. Given the power of cultural bonds, I can *sympathize* with the exiles' descendants' *desire* to claim (I can't bring myself to say "*re*claim") their ancestors' home. But I cannot agree that they have any *right* to do so at the expense of new occupants of the vacated real estate.

In intermediate cases, where all the original parties are deceased but not as long gone as the Tsong Zee forebears, the relative strength of claims may be harder to assess. In general, though, it seems to me that the farther in the past the injustice occurred, the less tenable any contemporary claim becomes. Yes, it may well be true that your great-grandfather swindled mine, and that if he hadn't done so, I might be much better off because the intervening generations would have kept building on Great-Grandpap's fortune. But Grandpa might just as well have squandered the whole fortune, leaving my father (and me) penniless. All kinds of things might

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have happened in those years. It's not at all clear how my situation would be different if things had gone differently back then. "Reparations" *might* give me something that I would have had anyway; or they might leave me far better off than I would otherwise have been, without my having done anything to earn the improvement. And they would certainly come at the expense of harm to individuals who have done absolutely nothing to me, and nothing to warrant punishment.

This is *not* to say that no harm was done, those many years ago, or that the atrocities committed by our (or anybody's) ancestors were all right. History is just full of absolutely hideous deeds committed by some human beings against others. They are tragic, regrettable, deplorable—and unchangeable. No amount of making one group of descendants suffer, to give unearned "reparations" to another group who haven't personally earned them, can wipe out the past wrongs or unhurt the real victims (who are now dead and beyond helping). Such efforts can only create new hurts and sources of bitterness. Even "apologizing" for our ancestors' misdeeds is at best an empty and meaningless gesture. We did not make them do what they did, chances are that *they* wouldn't have apologized, and we have no right to pretend to speak for them.

And history is *so* full of such atrocities and injustices that it's generally impossible to determine what "should" have been. Practically *all* of us can point to evil things that were done to our ancestors. As Mark Twain wrote, "[Man] sets himself apart in his own country, under his own flag, and sneers at the other nations, keeps uniformed assassins on hand at heavy expense to grab slices of other people's countries and keep them from grabbing slices of his, with the result that there's not an acre of ground on the globe that's in possession of its rightful owner." So even if you start allowing *some* claims for offenses committed generations ago, where do you stop? If you go back enough generations, you'll find that most of us have ancestors who either were victimized or rode roughshod over others, or some of both. Many parts of the globe have changed human ownership many, many times. Which one is "right"?

Between that dilemma, and the huge uncertainties in what each of our ancestors might have done with *their* ancestors' lands and fortunes, I can see only one course that can be generally advo-

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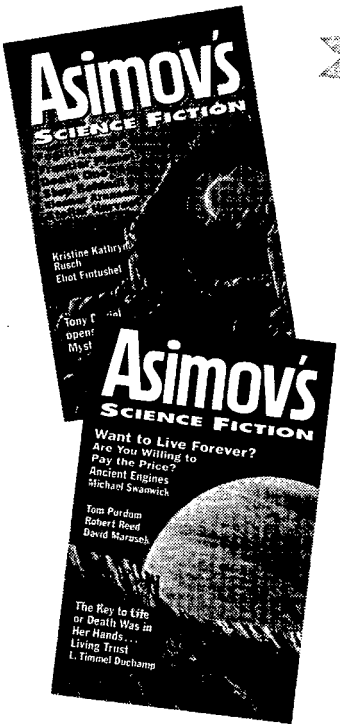

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cated for such things. Somehow we must teach our descendants, everywhere in the world, to understand, deep down, the differences between groups and individuals—for example, that a whole group does not incur guilt for every misdeed by any of its members, and that no one incurs either guilt or entitlement by being born into any group. And we must teach them to understand, deep down, that some bygones *must* be allowed to be bygones, because there is no longer anything meaningful and just that can be done about them.

All of us are the products of a vast web of our ancestors' defeats and victories, some big, some small. Undoubtedly some of those have given some of us advantages or disadvantages that we don't "deserve," but we're stuck with them. We must all understand that we have to start from where we are to build the best lives that we can. The fairest thing that we can do for everyone else is to try to insure that they all have equal opportunity to do that. But what they actually achieve will still depend on their own abilities and initiative—and a whole future full of unforeseeable events, some of which, like so many in the past, will be unfair and unjust.

Each of us will have to overcome those as best he or she can; but dwelling on a past we can't even remember, much less change, is unlikely to be a productive way to do it. A more sensible attitude was well reflected in a passing comment by Greg Bear, in a tribute he wrote for the SFWA Bulletin when his father-in-law, Poul Anderson, received a Grandmaster Nebula Award: "His Danish ancestors pillaged my English ancestors, yet his daughter chose me to be her husband and father his grandchildren."

Or, in a quote I saw attributed to Wendell Phillips, "Common sense does not ask an impossible chessboard, but takes the one before it and plays the game." □

Half our life is spent trying to find something to do with the time we have rushed through life trying to save.

— Will Rogers

Maybe it was that way in Will's Day, but now there are too many others eager to do that for them.

— Kelvin Throop

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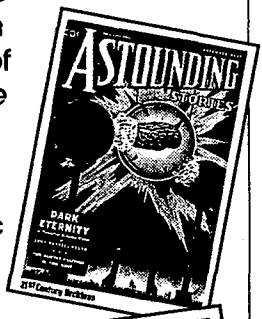

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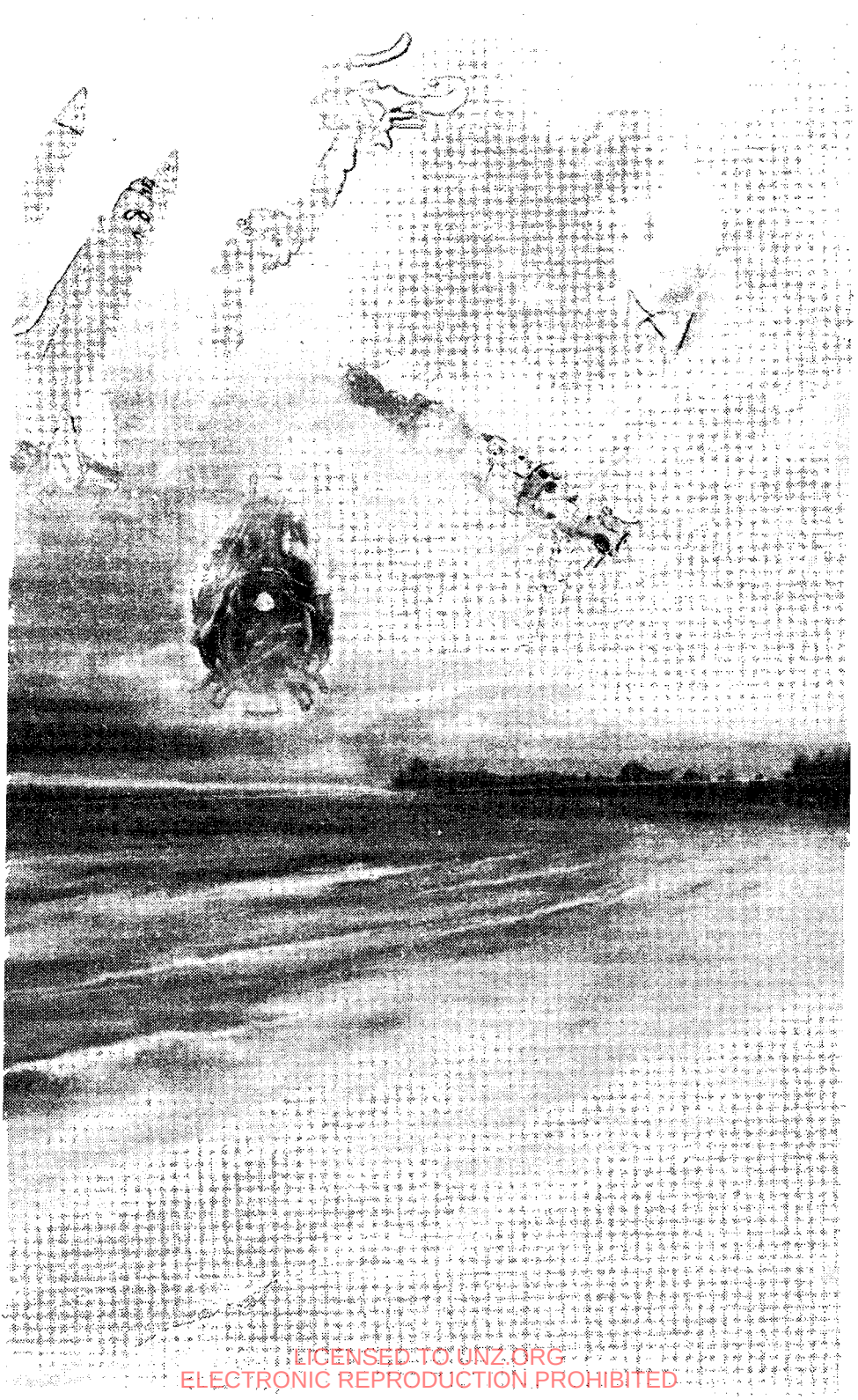

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Paul Levinson

LATE LESSONS

Most of us have something in our lives that we'd get rid of if we could. But what if that something is essential to something else we need?

Illustration by Randy Asplund

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Jeff and Laura walked hand in hand past lush Victorian vines, in the Haupt Conservatory of the New York Botanical Gardens in the Bronx.

"There's a timelessness about this place," Jeff said. Antique gardens always had a special attraction for Laura and him—perhaps because it reminded them of that night long ago, in Wave Hill across from the Palisades, in the 1960s.

Laura just smiled. They entered a room with a skylight dome, slightly cloudy and cracked now with age. A keen blue sky shone through anyway.

Jeff breathed in the honeysuckle and looked at the dome. "Hard to believe it's finally up there again," he said. "They took their time."

"They had to be careful," Laura said. "The Discovery has to fly a successful mission. It was worth the thirty-two-month wait. It'll deploy its communications satellite and come back home with its crew safe and sound. And the space program will slowly recover."

Jeff shuddered. He recalled the last launch they'd seen—the Challenger. They hadn't the heart to see this one launch in person. And they had tried to stay far away from the space program after the Challenger—let the world take its natural course, the course Laura remembered. That was the best way to get back on track in space.

"There are some nasty things coming up soon that I'd like to stop," Jeff said. "The Pan Am plane blowing up over Scotland is the worst, I think—that's due to happen right before Christmas—but I guess we have no choice but to leave well enough alone for the sake of the space program. At least 1989 looks to be a pretty good year."

"Yeah," Laura said, patting her belly and smiling. "I'd say a *very* good year." She was six weeks pregnant with Jeff's child.

"It'll be a good year to be born," Jeff said, and pulled Laura close for a gentle hug. "Berlin Wall comes down, beginning of the end for the Soviet Union. Not the greatest for space—though that should be OK now with the US program in gear again. But a good year for freedom."

"Don't be so sure about the Soviet Union," Laura said. "Andropov's a pretty tough customer."

"Loser." Laura shut off the television. "His voice is like—what's that numbing stuff the dentist gave me last year?—novocaine." Michael Dukakis had just been talking about the economy.

"He's the least of our problems," Jeff said. He had just returned from a long microfiche session at the NYU Bobst Library.

"Don't worry, honey," Laura said and kissed him. "They'll have it all up online in the next decade or two."

"Right," Jeff said. "But that's not what I'm worried about. I checked the newspapers almost day by day. Brezhnev dies all right on November 10, 1982, and Andropov succeeds him. And that's it! In my timeline, Andropov dropped dead in 1984, some old guy Chernenko took over, he kicked the bucket in 1985, and Gorbachev's in—with *glasnost*, *perestroika*, the end of the Cold War. It's in every mirrorim-book in every school."

Laura shook her head. "None of that at all where I come from. The Soviet Union's still going strong a hundred years from now. They play a major role in the space program in the twenty-first century—"

"How could I have missed that?" Jeff barely heard her. "I mean, I've just been assuming these past few years that Gorbachev was in power . . ."

"You weren't here during that crucial time," Laura said. "Remember? You took Landry's damned device straight from 1972 to 1986."

There always was an edge in Laura's voice when she spoke of that, and Jeff couldn't blame her. He had left her alone for fourteen years, living through realtime the hard way, while he had made that desperate attempt to get himself on board the Challenger. He had

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been willing to sacrifice his very life for the space program . . . The space program . . . was that truly the only thing that mattered in this world?

"And after the Challenger, you were still thinking day and night about the space program," Laura said, almost reading his thoughts like she always did. "You still think about it day and night."

"Did the Soviet Union do . . . much damage in your twenty-first century?" Jeff asked.

Laura made a face. "Not so much the Soviet Union. But, yeah, a few of its client states, especially in the North Atlantic dome."

George G. Landry walked along the beach, and squinted at the dawning sky.

"So quiet, so clear," his companion said, a woman with carbon hair and violet eyes, in her early twenties. "Hard to believe a hurricane's roaring up the coast—they say it'll hit us here on the Cape in a couple of hours."

"There's a storm roaring through the Soviet Union right now," Landry said. "Much worse than a hurricane. Human backlash . . . They say it could wash away everything that we've worked for."

Karina put a toe in the water. "Warm as a bath," she said. "There's nothing you can do about Moscow now. It's out of your hands. We'd better get back to the cottage and start boarding up the windows—Hurricane Bob could blast it to pieces."

"Yep, out of my hands," Landry said. "Pity you can't board up timelines as easily as windows."

"Well, you've done more than most," Karina said. She took his hand and steered him back in the direction of their little cottage on the bay. "And all of this may yet turn out your way anyway."

"Hey, folks," a man called down from a cottage near theirs. "Gonna be a nasty one—I'd get out of here to a shelter if I were you. The Brewster Elementary School has one—and I believe Ocean Edge is taking people in."

"Thanks, Gil," Karina shouted back. "I see you and Chris got most of your rentals boarded up already."

"Ya," Gil answered. "This one's gonna be one to remember—the hurricane of August 19, 1991."

Sam McKenna had aged remarkably well in the past sixteen years, Jeff thought—though not as well as Jeff had appeared to age, of course, because in fact Jeff had only aged two years, from 1986 to 1988, having travelled instantly from 1972 to 1986 courtesy of Landry and his fast track to the future.

Sam had apparently accepted Jeff and his story when he'd reappeared after the Challenger explosion—the corrected but still tragic explosion, the one that didn't veer off course and take out that schoolhouse in Miami—because professors after all were like that, known for their penchant to suddenly take a special last-minute appointment in some other part of the country, even the world, that started for a year but grew into a decade or more. At least, that's what Jeff assumed Sam believed. For all Jeff knew, Sam really thought he was a madman and was just humoring him. But that was OK too.

Sam certainly always played along with Jeff as he spun out what must have seemed to Sam to be wild what-if scenarios . . . What if Nixon had nuked Cambodia, what if the space program had died a total death in 1986 . . .

Now Jeff sat on a bench with Sam in Washington Square Park—not far from where Jeff had first hustled into the past, to November 1963, all those years ago—and spoke of a new what-if, of a Soviet Union headed towards disintegration and freedom, of a dictator named Gorbachev who paradoxically used his totalitarian powers to order his society to be more open, his people to be more democratic. And of a people who once so charged removed that totalitarian system, including its benevolent dictator, altogether . . .

"And this revolution proceeded with-

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out a hitch?" Sam asked. He was a political scientist, so this scenario was catnip for him.

"Well, nothing in this world proceeds without a hitch," Jeff replied. "You know that. But this one unfolds pretty smoothly—the only serious threat crops up about two and a half years from now, in the summer of 1991, when the hardliners stage a brief coup against the liberating dictator."

"Against Garbage . . . chef?"

"G O R B A C H E V," Jeff spelled out the name. "Gorbachev—though, if I remember correctly, it was pronounced something like Gahr-bah-chawf."

"If you *remember correctly?*" Sam asked, and laughed.

Jeff returned the laugh. "Well, I really get caught up in these alternate history scenarios—"

"Right, you're a regular *Man in the High Castle*," Sam said. "You oughta write some of this stuff up. But OK—what do you see as the result of this hypothetical coup against this hypothetical self-effacing dictator?"

"In the reality I'm sketching, it fails."

"Hmm . . . OK, so there's your access point," Sam said. "You remember the article I had in the *Atlantic Monthly* last year—'Other Choices'?"

"Yeah . . ."

"Well, its thesis is that people with clear agendas and some kind of power do best not to stage a revolution themselves, but wait until a time of turmoil—when someone else has incurred the great start-up risks of getting the turmoil underway—and then strike. In fact, that's how the Bolsheviks came to power in Russia in the first place—riding on the coattails of the democratic revolution against the Czar."

"And the relevance of this to the failed coup against Gorbachev in my alternate history would be?" Jeff pressed.

"Obvious," Sam said. "If there's some sort of coup against Andropov in 1991 in our current reality, that's the time to get rid of Andropov and install Gorbachev. The Soviet Union turns out just the way you want, except a few years later."

"Right," Jeff said. "But how can we know if there'll even be a coup against Andropov?"

"We can't," Sam replied. "But I know someone who might know—Yelena Grinko. She used to be Professor of Philosophy in Minsk—she has the Soviet political climate down pat. She'll be in New York next month. Shall I arrange a meeting?"

Jeff nodded, and thought: the last friend of yours that you arranged for me to meet was George G. Landry.

"Dammit, I can barely hear you." Landry pulled the phone away from his ear, and shook it. "Damn Soviet Union—I'd have a clearer connection to Mars."

"Take it easy, honey," Karina said. "It's the Cape Cod service—full of static in the best of times." She stroked his shoulder.

Landry turned his attention back to the phone. "Yeah, that's a little better. No, I'm not in the car—we've got bad weather here, and the car phone is useless. I'm in the basement of some school. No, no point in my giving you the number—I don't know how long we'll be here—"

"Excuse me, sir. Will you be on much longer? One of the campers needs to make a call—"

Landry started to curse—

Karina overrode him. "He'll be off in a minute," she said, soothingly. "It's a business emergency."

"OK," the woman said. "I'll come back in five minutes. Please have him off by then. Otherwise—"

"Absolutely," Karina said. "I promise."

"OK," the woman said. She gave Landry a glare, then strode away.

"Nothing like a counselor who takes her campers' needs to heart," Karina remarked.

Landry was straining to hear what was coming through the phone. "OK, you got him, good. Right. That's good. OK. No, no—you don't do a *thing* to him until you get the word from me."

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* * *

"The Soviet Union is a sick country—we suffer from an illness, an illness of the mind, that was introduced into our country more than seventy years ago. That's what you must remember when you deal with us—you are dealing with a society not in its right mind." Yelena Grinko ended her talk to a round of sustained, impressed applause.

"She's got a pair on her," Jeff said over clapping hands to Sam, who had just returned from the bathroom. "To talk like that and not be worried about retribution back home."

"She's not going back home," Sam said. "Her dream is to land a job in a philosophy department over here. That's what every Russian academic in America wants."

They left the auditorium in Tisch Hall, and adjourned to Gavin's. "One thing I can say about NYU," Sam said, "the food's a lot more exotic than up at City College. Too bad Laura couldn't join us."

"Well, her taste in food is changing," Jeff said. "But you used to love the soul food up in Harlem."

"I did, but it always laid heavy the next morning."

"You sound like my great-great-grandmother," Jeff said.

Yelena joined them a few minutes later. Sam made the introductions.

"That was a courageous speech you gave," Jeff said.

Yelena smiled over her menu. "I deconstruct my country."

"I'll have the escargots to start," Sam said.

Yelena frowned. "I had them with Derrida in Paris last May—they gave me, how do you call it, the hives . . . "

"Try the shrimp," Jeff said. "They're delicious."

"Yes," Yelena said, "they're very fresh. I had them here last time."

"So do you see any chance for improvement in your country?" Jeff asked, as the waiter scurried away with the orders, not a single one for a main course with a backbone.

"No, I'm pessimistic," Yelena said. "Andropov is a very ruthless man—far brighter than Brezhnev. He's consolidated his power in the past seven years."

"And the stirrings in Poland? And Hungary?" Jeff asked.

"Andropov will crush them." She shattered a breadstick on the table. "Just like he did in East Germany last year."

Jeff sighed, shook his head.

"You see, Yelena," Sam said, "my friend has an idea that there's a new regime under the surface in the Soviet Union—that somehow something in your recent history went wrong to suppress it, but that maybe there'll be a chance in a few years to get it on course again."

Yelena looked puzzled, then laughed. She turned to Jeff. "Ah, you are a science fiction writer then—like Isaac Asimov! He was born in Russia, you know."

"Yeah, I know," Jeff said.

Yelena put her hand on his. "I'm only making a joke at your expense, forgive me." She smiled, then grew very serious. "But, you see, there is nothing bubbling under the surface in my country now, except for more illness. Even if there was a revolution tomorrow, no one would know what to do. My people are all quite happy being children."

"No talk at all of openness, of a new vision?" Jeff asked.

"A new openness? You mean *glasnost*? Shevardnadze talked about *glasnost* during his leadership of free Georgia in March of 1985, but . . . "

"Andropov ended that and had him killed that September," Sam said.

"Yes." Yelena nodded, gravely. "And I left my country then for the last time, never to return. No, the last chance we had for any freedom was maybe 1982 to 1984, before Andropov fully mastered his office. By the time poor Shevardnadze made his stand in Georgia in 1985, it was already too late."

* * *

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"God damn you! I'm almost five months pregnant! Doesn't that mean anything to you?" Laura turned away in a fury.

"Of course it does," Jeff replied. "It's just—"

"Just what?" Laura whirled around. Her eyes were brimming with tears. "It's always something with you, isn't it. You think you can change the world, perfect it to your ideals. Don't you get it yet? Haven't you learned anything in all of these years? Nothing in this insane loop of a universe we're in ever turns out the way we plan it. If were lucky, very lucky, maybe we find we're in the right place at the right time, and somehow tip the balance in our favor."

"We tipped the balance in favor of a Challenger explosion that didn't destroy the space program," Jeff said. "Actually, I tipped nothing—*you* tipped the balance—"

"That's what you wanted! That's what *we* wanted, remember?"

"Yes," Jeff said. "That's what we wanted. A world in which space exploration had some chance in the twenty-first century. The world you knew. The world I wanted. But what I didn't know was that that world was somehow tied to the Soviet Union continuing on into the twenty-first century. I didn't want *that* world—it may be too much of a price to pay."

"Maybe the Soviet Union is necessary to keep humanity in space in the twenty-first century and after," Laura said. "You can't know that it isn't. Maybe it is—after all, Sputnik and Gagarin and the Soviet Union started it all in the first place. And before that, Hitler and the V2s. Those origins are the same in both of our realities. Maybe space needs some kind of totalitarian hand to help push it forward."

"No." Jeff shook his head. "I can't accept that. We've got to try for something better—the best of both of our realities. A vibrant space program in the twenty-first century *and* a world free of sick dictatorships. You should have heard Yelena Grinko—"

"I don't give a damn about Gringo," Laura said. "You can't just splice two different realities together like they were a piece of tape."

"I can't just leave the world like this," Jeff said.

"How do you propose to get back there? Landry's vanished, his Western Coordinating Sciences Institute's been replaced by some sort of online psych center. Even if you went back in time, you don't speak a word of Russian—you'd be arrested as a spy and sent to some frozen gulag hell the minute you set foot in Moscow."

"I know. I haven't figured it all out yet. Yelena has some ideas—"

Laura stalked out of the room. Then she stalked back in.

"You want the best of both of our realities—here she is." She pulled Jeff's hand, and put it against her midsection.

Jeff kept his hand there. Then he got down on his knees, and put his ear to the same place. Amnio had told them just last week that their baby was genetically fine—at least, according to the dim lights of twentieth-century science—and she was a girl.

"I love you," Jeff said softly, to Laura and the baby.

"I don't like conducting business this way. Strangers all around us, I feel like someone's listening to my every word, it's absurd." Landry looked fitfully around the hall.

Karina followed his gaze, stopping on a nearby couple. "That guy's hand is halfway up her shorts—they couldn't care less about our business."

"All it takes is one—one person, one act, one word at the wrong time—and what we set in motion will be as out of control as this hurricane. This place is way too public."

"The hurricane is precisely the reason we're stuck here now," Karina said.

"It wasn't here the last time," Landry said.

"Weather patterns are even less pre-

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dictable than people—you say so yourself in the primer—"

"OK folks," a voice boomed down the hall. "I think it's safe to go home now. Watch out for fallen trees and downed wires. It's a real mess out there. Bob took his toll."

Landry and Karina eventually made it to their car, and on to Route 6A.

"Jeez," Landry said, as they turned onto Ellis Landing Road. A huge locust tree was on top of the pretty yellow cottage on the corner, crushed now in the center like a piece of rotten cake. The road around it looked like the floor of some insane giant's barbershop, strewn with cuttings and clippings and trees pulled out by the roots.

They made their way through the debris. "Our cottage looks OK." Karina pointed to the "Sea Piper" silhouetted at the end of the road against the bay.

"So far, so good," Landry said.

But on closer inspection, the view was less promising. A thick branch had taken out their overhead phone wire, and they discovered once they were inside that their electricity was gone.

"I thought I heard someone at the school say that they were shutting off the power for this whole part of the Cape," Karina said, as they settled in and took stock. "As a safety measure, until the central cables are repaired." She handed Landry a glass of chablis.

He sipped slowly, said nothing.

"Well, it is romantic in a way," Karina said, lighting a hurricane lamp. "Food in the fridge will definitely be good this evening. If we don't open the door too often, most of it should still be OK in the morning."

"I'm more concerned at this point with food for thought," Landry said, scowling. "I can't command the situation if I have no information." He sat down on the couch and began fiddling with the small transistor radio he'd taken out of the bathroom. "Nothing but static and more bullshit about the hurricane," he said.

"Well, keep trying," Karina said, and pushed over a stool so she could reach the top cabinet. "I'm pretty sure I saw another kerosene lamp up here somewhere . . ."

"Ah, wait a minute," Landry said. "Here's something—"

"—no further word as yet on the fate of the Soviet Premier," a crackling voice on the radio intoned, "though the BBC says—"

Someone rapped sharply on the front door.

"Looks like some kids from the school," Karina said. "Maybe we left something there . . ."

She opened the door.

She saw a fist.

But instead of hitting the door it veered towards her face . . .

Her head throbbed, her stomach ached, her eyes felt like broken glass . . .

She lifted herself up slowly from the floor. Across the room, a bunch of people were around Landry, slapping him around, talking angrily—in Russian. They all had their backs to her, except Landry. One had a knife . . .

Landry caught her eye for a second, and gave her a signal, a subtle signal, but as clear as day for her. It said: get the hell out of here.

"You idiots," Landry said loudly, perhaps to distract their guests. "You can't do anything to influence events over there by beating on me here. Everything's already in motion—"

Karina bolted out of the door. Her only chance for escape was the beach, which stretched for miles in either direction, with houses aplenty, at the bottom of their long flight of stairs.

But a big ugly man was on top of the stairs, blocking her egress, turning slowly around now to face her—

She rushed towards him, shoved him with all of her might, before he had turned fully around. She caught him off balance, and he fell, startled, backwards, down the weathered wooden stairs.

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His head hit the big rock that served as the stepping stone at the foot of the stairs, making a sound like the cantaloupe that had slipped off the seat of the car onto the pavement last week . . . Karina stepped over the rock and the head, and ran in the direction of Orleans on the sand.

She ran and ran. The beach felt crusty under her feet, sand half baked in the sun that had prevailed after the hurricane. It was easy to run on . . .

She looked behind her several times. Not a soul on the beach—unless she counted the terns and sandpipers.

Finally she saw the cottage—set off on a rise, about a quarter mile past the old Linger Longer by the Sea resort. The bleached grey cottage was their fallback place, George had said, in case anything went wrong.

She'd never been here before, but now she'd have to trust her fate to the people within. A nice couple with a little boy, as she recalled. And an old grandmother, named Sarah.

Three thousand miles away, two and a half years earlier, near another beach, Jeff joined Yelena for lunch at the Valencia Hotel in La Jolla.

"The fish in this restaurant are delicious," Yelena said. "Very fresh!"

"Yep," Jeff said. "We go for fresh fish in this country."

"And the vegetables," Yelena said, carefully cutting a piece of cauliflower. "So fresh, especially for the winter!"

"Well, it's never really winter in southern California, even in February."

"Yes," Yelena said. "I looked out of my window this morning and said to myself, 1989 is on its way to being a beautiful year in California."

"Your room is comfortable?" Jeff inquired.

"Oh yes," Yelena said. "The water was hot, and the little bottle of vodka was cold—perfectly chilled! Thank you!"

"I'm glad—you can thank the Salk Institute for that." Jeff had arranged with Jonas Salk for an invitation to Yelena to come to La Jolla and give a series of lectures at his Institute. Jeff had met the creator of the first polio vaccine years ago at a AAAS Conference—and had found him, in addition to being a brilliant scientist, an equally brilliant, if unrecognized, philosopher of science. Salk's face seemed to shine like a light bulb when he talked about his theories of human survival—and Jeff saw in him, much as he did in Sam McKenna in another way, someone who perhaps was willing, and able, to understand at least a bit of the whirring paradox that was Jeff's life.

They had stayed in sporadic contact over the years. But today, Jeff's interest was another institute in La Jolla—the one that had once been the Western Coordinating Sciences Institute, that had housed George G. Landry and a time-travel machine, much sleeker than Jeff's original Thorne, that had whisked Jeff from 1972 to 1986. That had been the last Jeff had seen of any time-travel machine. And the last Jeff had seen of Landry and WCSI as well.

The building it had been in was now home to some kind of online psychotherapy seminar group. Except—

"And how did your expedition go this morning?" Yelena asked, as if she were peering into his mind.

"Odd," Jeff said. "Bizarre. Some of the people sitting at their computers were there in 1972—they admit it! They remember Landry, but are vague on just what happened to him. They remember WCSI, but say it merged into some other organization. So what are they doing there now—what are they, specialists who come with the office building?"

Yelena laughed. "I've seen stranger things in this world, believe me!"

Not as strange as what I'm about to tell you now, Jeff thought. So far, all he told her was that he had arranged for the Salk Institute to invite her to La Jolla, so she could be here as he tracked down Landry and WCSI, because they had some crucial relevance to the Soviet

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Union. No Russian could turn down an invitation like that—for that matter, few American academics would either.

"How badly do you want things to change in the Soviet Union?" he asked.

"Very badly. But I told you, it's hopeless now. Andropov is too strong."

"Yes, I understand that," Jeff said. "But you also said Andropov was vulnerable when he first took over—from 1982 to 1984."

"True," Yelena said. "But—forgive me—so what?"

"Don't ask too many questions just yet," Jeff said. "Just play along, OK?"

"Sure—OK—I like games."

"Do you think that, if someone had a mind to do it—if someone really wanted to, and had the connections—that someone back in 1982 to 1984 could have forced Andropov from office—could have replaced him with someone perhaps not so dictatorial?"

Yelena considered. "Yes, it's possible. Of course. But I wouldn't make a bet on it. Our system is very stable, as you know—usually death is the only sure way to get someone out of office. Of course, Khrushchev was forced to leave, and Kosygin had to move over, but that was back in the 1960s—still lots of instability then, with Stalin dead only a decade. But by the 1980s . . . " Yelena shrugged. "No, by the 1980s, death is likely the only way."

"That's what I was afraid of," Jeff said. "So if we really wanted to do this job—still playing along with my game—someone would have to kill Andropov, preferably in his first few years in office, before he'd had the chance to strengthen his central authority beyond even what Brezhnev had."

"Yes," Yelena said, clearly relishing even the hypothetical prospect of a murdered Andropov. "I would agree. And who would you select to implement this . . . assassination?"

"Someone who really knew her way around back then—and there," Jeff said. "Someone with the knowledge to appreciate the benefit that Andropov's death could bring to the Soviet Union—and the world. Someone with the courage to stand up to such a dictator. I was thinking of you."

Yelena's eyes bulged. Her lips struggling between laughter and some darker emotion. Whatever she was thinking, Jeff counted it as a good sign that she hadn't thrown down her fork and walked away.

"This isn't really a game, is it?" she asked. Now her face was just ashen.

"I'm not going to insult your intelligence and say I know you'll think this is crazy, but I'm a time-traveler. You deserve better than that standard rap, and frankly, I think it's boring." Actually, Jeff had said that only once—to Laura, back in 1964—but it indeed bothered him to even contemplate that lame form of admission, the time-traveller's classic confession.

Yelena just looked at him.

"So here's what I *will* tell you," Jeff continued. "Yes, I'm a time-traveller. Yes, the science is possible—that's how I'm here. But there's nothing crazy about it—paradoxical, oh yes, paradoxical, more than enough self-defeating loops to *make* you crazy, that's for sure—but on its own terms it's quite logical. You can go back in the past and change events. It's not easy, but it can be done. I know that, because I've been there, done that. I spoke once to my great-great-grandmother, and she relayed a message about that to my grandfather—when he was just a little boy on Cape Cod—and he relayed it to me. *After* I'd travelled back in time, and already lived through part of a life in which he hadn't said anything like that to me the first time. And I've also changed a larger event—a much larger event. Or helped to change it. The universe puts up a lot of resistance to these things, and . . ." Jeff became aware that Yelena had yet to say a word in response. "Is any of this getting through to you? I mean, I know English isn't your native language, and—"

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"I assure you, I'm understanding every word of it," Yelena said. "I read H. G. Wells, I read Dr. Isaac Asimov, I read Mr. Robert Heinlein. Most of their works aren't available in the Soviet Union—but I have read every one since I've been in the West. So I know about time travel. We Russians know a lot of things—don't let *your* propaganda fool you. In some things, we know more than you."

"OK," Jeff said.

"So. You want me to go back in time and kill Andropov. For me, the thought of my killing someone—anyone—is far more crazy than going back in time. What would you have me do? Shoot him? Put poison in his tea? I'm not a murderer. But somehow, I don't think the problem will even arise. Obviously this George Landry and his coordinating group have something to do with your time machine, but you say neither of them are anywhere to be found. So how could anyone even get back to 1982 from here?"

Jeff smiled. "Music is my guide."

"What?"

"I was a professor of popular culture in the twenty-first century, cultural history of the late twentieth is my specialty," Jeff said. "I know the music from the current period—when each hit record was released—like the back of my hand."

"I love rock 'n' roll music," Yelena said.

Jeff nodded. "When I first came here in 1972—to see George G. Landry—there was a guitarist sitting in front of the building Landry was in, singing a song by John Lennon. No big deal about that. Except for one thing: the song was 'Real Love,' not released by the Beatles until 1995, years after Lennon's death."

"And your point is?"

"My point is that there obviously was some cultural contamination from 1995 in 1972—which means there had to have been some backwards-in-time contact. Indeed, I'd guess that there have been time machines cutting this way and that way in time, touching just about every year, emanating from that building the Western Coordinating Sciences Institute was in. Think about it. It was *once* a time travel facility—but there's no such thing as just 'once' where time travel is concerned. If the building housed a device that went, say, from 1972 to 1995, then that same building housed a time travel device, for however short a time, in 1995—regardless of what other purpose the building may have served then. My guess is that if we staked out—kept an eye on—that building long enough, sooner or later a time machine would plop right into our lap. I could probably arrange for a more permanent appointment for you somewhere out here in La Jolla. Perhaps at the University of Southern California—"

"You want us to watch that building for six years, until 1995?"

"My guess is we'll find a time machine there much sooner than that—"

"Forget it," Yelena said. "It's still impossible that I would go back in time and kill Andropov. Like I told you, I'm not a murderer."

Sam McKenna was at Laura's door, humming a Beatles song.

She let him in, then gave him a long hug. The two had grown very close during Jeff's 1972-1986 absence.

"He'll be back soon," Sam said, taking off his winter coat. "It won't be like last time."

"I don't know," Laura said. She took the coat and put it in the closet. She liked the smell of it.

Sam closed his eyes and hummed the Beatles' refrain again.

"You love that line, don't you?" Laura asked.

"Not so much the line, but the word—'awoken'—and the D minor seventh chord swelling restlessly underneath it," Sam said. "C, D minor 7, G is a very common progression, really. But in John Lennon's mouth it's magic."

"Jeff loves it too," Laura said. "All of Lennon's music. It sliced a piece of his heart when Lennon was killed."

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"As it did us all."

"We heard an advance cut from the Travelling Wilburys album last month," Laura said, finally showing Sam to a seat and fetching him his customary ginger ale. "It made us cry."

"Wilburys?"

"Yeah," Laura said. "A temporary, studio superstar group. Bob Dylan, George Harrison, Roy Orbison, Jeff Lynn, and Tom Petty—extraordinary sound. Spanning the fifties to the present."

Sam sipped his soda.

"Jeff said the group was unreal," Laura continued. "It existed, in a manner of sorts, in our world. But it was really a glimmer, a bleed-through, of something else entirely, from an alternate universe."

Sam smiled. "I think we should have another talk."

Felice Montag met Jeff and Yelena at the evening door of the pastel grey building on Silverado. She frowned. "I was hoping you wouldn't come."

"That's the thanks I get for helping you unravel that packet-switching problem, huh," Jeff said, with a smile. The primal plan—the very first of so many many plans he had been working through for so many years—had been for Jeff to have arrived a few months before the Challenger explosion in 1986. He had thus been trained in 2084 to be thoroughly adept at personal computer technology in the 1980s—no telling when and how that might come in handy. It of course had been no use to him at all when his Thorne had unexpectedly landed back in 1963. But here in 1989, in an early online scholarly network centered in this building in La Jolla, Jeff's antique computer savvy had been just the thing to ingratiate himself with a harried programmer over her head in too many packets of traffic and too few lines to handle it.

"Well, yeah, you did save my butt yesterday, and I really appreciate it, and that's why I'm here." Felice ushered Jeff and Yelena in, looked out and around the parking lot to make sure no one was watching, and closed the heavy door sharply behind her. "All right. The deal is I take you upstairs, you've got thirty minutes to look around and your photographer takes any pictures she wants, and then we're all three of us out here. And let's hope this is my one and only excursion into industrial espionage."

Jeff had worked with Landry and his colleagues back in 1972 on the first floor of this building—the same floor that Felice and her people now occupied, and which Jeff had visited three times since he'd arrived a few weeks ago in La Jolla, including the propitious occasion yesterday when he'd overheard Felice pulling her hair out over her computer, and he'd offered his helpful suggestions. The second floor, however, was the one he wanted to carefully inspect. This was the one he had seen just twice in 1972: once when he'd first talked here to Landry, one more time when he'd entered the neo-Thorne for the instant elevator to 1986. This was the upstairs to which Felice now took Yelena and Jeff. "So I'll see you downstairs in half an hour," Felice said, and left.

The layout was, unsurprisingly, nothing like what it had once been. Landry's office and the section behind it that had housed the time-travel device were simply gone—dissolved now into rows of primitive 286 computers, each attended by a chair upon which some user could sit and address the computer from the front, and a modem with a phone jack through which the computer could talk to the rest of the world from the back. That world was already in the first stages of the revolution that would let people do all of this from their homes and places of business, soon from their pockets and palms, but it still clung, even at this late date, to the penny-arcade amusement-parlor set-up that harkened back to Edison and his kinetoscopes. Old ways of doing things died hard, like the heartbeat of recalcitrant

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history itself which Jeff always seemed to be trying so desperately to alter.

"You see anything here which looks promising to your needs?" Yelena asked, snapping photograph after photograph.

"No," Jeff said. "But there has to be some place for it here—some place for an artificial wormhole to open up and disgorge its vehicle without smashing all of these gleaming antiques."

"Antiques? Hah! In my country, these pretty toys would be—how do you call it?—the cat's meow!"

"Well, let's see what this monocular cat looks like with a little electricity in its eye." Jeff sat next to a terminal and pressed its power switch. The beast grunted and gargled and eventually put up a C prompt on its blue-green screen. "Right," Jeff said to himself, "this would be just before Windows made its grand entrance."

He pulled a $3^1/_2$ inch disk from his polo shirt and inserted it in the lower drive. The disk was thoroughly compatible with the 1.44 MB capacity of the drive, but thanks to a special algorithm—with which it had been formatted back in 2084—it could hold a million times that data. The key was that the disk always looked to the 286 write-head as if it were empty, and thus could be written to with more data. Jeff was sure that this mirage feature would be more than enough to capture all the text on any medieval network this knight in shining armor might be connected to. The puterwafer back in his hotel room could easily search the download for any relevant information, then decompress and display it for him.

But that was not the disk's most impressive feature: it was also intelligent enough to read twentieth-century encryption systems as if they were block letters on a kindergarten blackboard. If Jeff was right that this building still served as a port for Landry's time machine—and this seemed more than likely, given that Thornes and their descendants, as far as Jeff knew, traversed time, not space—then these computers and their networks might well bear some trace, some notation, of the time-travel operation. Jeff doubted that these information machines, creaky as they seemed on the surface, served no part in Landry's schemes. It wasn't like Landry to lavish his time on thoroughly useless window-dressing. . . .

Soon the intelligent agent in Jeff's disk was in every corner of this primordial virtual universe, cracking codes it encountered like eggshells, transforming the data regardless of its size into super-slick packets that were downloaded in just minutes on these arthritic 2400 bps modems. Of course, Jeff was assuming that Landry had used twentieth-century codes for encryption. But Jeff bet that Landry wouldn't have risked calling attention to himself by use of a code that wasn't of this century. "Camouflage in contemporary color is your best defense," Landry had advised before Jeff's departure to 1986. . . .

"Okeydokey, all done," Yelena said.

"Good, same here." Jeff removed his disk from the computer. If he was lucky enough to find in the data some schematic of this floor that indicated where the neo-Thorne materialized, Yelena's photographs might provide additional essential details.

"Let's go," Jeff said. They were back on the ground floor, thanks and goodbyes to Felice, with ten minutes to spare.

They had their answer—or part of it—two hours later.

Yelena was on the couch, half asleep, a glass of wine in her hand and a lock of blond hair over her eye. Jeff was at his puterwafer, soft as a bar of chocolate, a tenth of a kilogram—but, as the advertisements said where he came from, the human brain itself was only a kilogram, and look at all that *that* had done.

"Damn it!" Jeff exclaimed.

"No results from your search?" Yelena asked, groggily.

"No, I have a result. I found part of

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the schedule. There was an arrival here in December. None in 1989. Goddamnit—I *knew* I should have gotten on this sooner . . ."

"OK," Yelena said. "But that's progress—"

"No, wait. I was searching for arrivals. Let me try this a different way. Let's see . . . Departures . . . They're just as good as arrivals—a departure means a machine will be on hand. OK. Jeez!"

"What?" Yelena asked.

"There's a departure scheduled for mid-March—just two weeks and five days from now—"

"But—"

"One of us—I hope you—is going to take that machine back to November 1982, or sometime right after, at the beginning of Andropov's reign," Jeff said.

"Listen," Yelena said, now fully awake. "I haven't agreed to anything. I told you. I'm thirty-eight years old—too old to become some kind of hitman in time. I don't even know yet if I entirely believe you. But let's say I did. If what you're saying is true about time travel, and how it can change yesterdays, how can you even think about just kidnapping a time machine and keeping it from its original mission? For all we know, the only reason that you and I are here talking right now in America is because of something that the original mission made possible in the past. Fooling around with just history is bad enough. Fooling around with the history of *time travel*—the history that *makes* the rest of history, if there is such a thingis just crazy."

"Communism," Sarah Harris said. "After what the Czar did—pogroms, *gutenyu*, you shouldn't know from such things!— I don't worry about Communism. Anything is better than the Czar!"

Karina drank a cup of tea, lemon and sugar, with hands that still quivered.

"Would you like a sandwich?" Sarah started to open a package of rye bread. "You look hungry."

"No, please, Mrs. Harris. You've done enough just letting me into your cottage for a few minutes to rest. You need the food for your family."

"There's more than enough to go around!" Sarah said. "Yitzhak—my son—and his wife Marilyn and my granddaughter Rachel are stuck in Hyannis because of the hurricane. It's just me and Eli, my grandson, here. How much can a five-year-old eat? And I'm a ninety-six-year old lady—how much can *I* eat, I ask you? Please! I insist! Have a little something!"

"I eat a lot, grandma," Eli piped up. "Mommy says I eat a horse!"

Sarah laughed. "Eat *like* a horse, *tatteleh*. Anyhow—in my country, in Russia in the old days—a loaf of bread would last for a week! Even when I first came to this country, to Ah-mer-ica, for a penny I could buy a roll, for another penny a piece of herring, and eat like a queen!" She kissed her fingertips in a gesture that said how good it all was.

"OK." Karina relented. She was very hungry, another few minutes couldn't do any harm. She had covered her tracks very carefully from the beach to here. She had seen no sign of anyone in pursuit. . . . but the thought that she might be bringing down Landry's attackers on this unprotected, very old woman, not to mention the little boy, was too awful to even contemplate. She'd just wolf down the food, for strength, and leave—

"Here you go." Sarah gave her a plate with a sandwich. It was delicious—smoked whitefish with some sort of old-fashioned potato salad.

"It's wonderful," Karina said. "Very fresh!"

Sarah smiled, and placed another cup of tea right next to the plate.

Karina noticed that although Sarah's hands shook, they had an underlying strength—like an aged willow trembling in the wind, with tap roots that reached to the center of the Earth.

"That rain was really something today," Sarah said, as if she was on the same weather wavelength as Karina.

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"Yes, it was. But I guess I'm used to it. . . ."

"You don't come from this part of the country," Sarah said.

"Well," Karina began, then thought the better of it and bit again into her sandwich.

"You come from Russia, no?" Sarah asked.

"Is it that obvious?" Karina asked. She thought she had her American accent down cold. "I mean, lots of Americans use the name Karina."

"To me, anything Russian is obvious," Sarah said. "I lived there the first ten years of my life."

"I didn't spend that much longer there," Karina said. "My mother was Russian—but she also spent lots of time in America—"

"Was she a spy?" Eli asked, scooting out of the bedroom on a tricycle.

"Eli!" Sarah exclaimed, with just the right mixture of remonstration and pleasure.

"Yes, she was," Karina replied, in a hoarse, mock-conspiratorial whisper. "And she spied on many things."

"And your father?" Eli asked. "Was he a spy too?"

"Well, I don't know," Karina said, slowly. "I never knew my father."

"OK, Eli, let's play with that puzzle," Sarah interrupted whatever Eli was about to say. He ran off to get the toy.

"I'm sorry—" Sarah began.

"It's OK," Karina said, and smiled. "He seems like a very bright little boy—I love bright children."

Sarah beamed. "Eli is a *mitzvah*—a blessing—I don't have to tell you that. Marilyn is Yitzhak's second wife. His first wife—what's the use of talking—the doctors *killed* her, and it was supposed to be just a simple operation. Then thank God Marilyn came along. Yitzhak started his family late in life. But now they have Eli, and Rachel. . . ."

"He's a beautiful boy," Karina said. She patted her mouth with a napkin and stood up. "I'm feeling much better now—your tea and sandwich and conversation were the perfect restorative."

"You're not leaving so soon? Not in this weather," Sarah protested.

"The hurricane's over—I'll be fine."

"No, I insist—"

"No, Mrs. Harris, *I* insist this time. You've been very kind. But I have to leave now." I can't jeopardize your family a moment longer, she thought.

Sarah held up her hands in an exaggerated motion of frustration. "All right," she finally said. "But let me give you a little something before you leave."

"OK." Karina could see there was no point in arguing about this. "Can I just use the bathroom before I leave?"

"Of course!" Sarah pointed her in the right direction.

The package Sarah gave to Karina as she left contained another whitefish sandwich. "Please. I insist. Give this to George."

Karina nodded, and squeezed Sarah's hand.

There were tears in her eyes as she walked swiftly away on the beach—but in a direction further away from George's house.

He was most likely dead. Just like the vile Soviet premier whose death had been announced on the radio when she'd first entered the cottage of Sarah Harris. But Karina took no joy in that: his successors would be indescribably worse, with George unavailable to pull the strings. The future of that part of the world would make the hurricane seem, as Sarah might say, like a spritz on the beach. . . .

And for herself?

Her greatest vulnerability lay in the twenty-minute walk on the beach ahead to Orleans. Landry's attackers would have no way of knowing she'd been in the house of Sarah Harris, but it would be plain as daylight that she'd gone off in the direction of Orleans. . . .

If she could just make it there now, and the buses were running after the storm, the money in her wallet would

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get her to Logan Airport in Boston. There she could use a credit card to book the next flight to La Jolla.

There was nothing more she could do here in this August of 1991, except die at the hands of George's executioners. Her only chance was in the past.

"I've been wracking my brains, and I've come up with two possibly pivotal events at the end of March." Jeff was on the phone with Laura. He yearned to see her face—to catch the nuance in her lips, the glint in her eyes. Having a conversation like this without benefit of visual cues to guide him, to gauge the impact of his words upon her, was maddening. He could never get used to the lack of phone screens in this century. "I want to be as sure as we can be this time that something I do doesn't inadvertently flip my history into yours, or yours into mine, or wipe them both out—so let's check our recollections of history for March and see how they mesh."

"I'm listening," Laura said, tiredly. "I'm not sure I remember anything *specifically* happening in March 1989 anyway, but go ahead."

"OK. Bear with me. Both events are very well known. I wouldn't dare interfere with a time-travel arrival right before either of them, but I don't see how a time-travel *departure*—away from this time—waylaid by me, could affect these events. One is the Exxon Valdez—it spills eleven million gallons of crude oil off the Alaska coast on March 24."

"Right," Laura said. "That's in my history too. Serves as a high water—or oil—mark of the danger that fossil fuel can pose to the environment."

"Good," Jeff said. "So we're OK on that one. The other event is Fleischmann and Pons—"

"Who?"

"Drs. Martin Fleischmann and Stanley Pons—they announce the first evidence of cold fusion at the University of Utah on March 23. I remembered that date as soon as I pegged the Exxon Valdez. The two dates are a classic in techno-cultural history—the solution to fossil fuel pollution unveiled but one day before the most publicized incident of pollution in the century. Every school kid knows it. There's a famous *Analog* article about that coincidence by Mallove that everyone reads in the seventh grade—"

"Never heard of it," Laura said.

"Never heard of what—*Analog?*"

"Of course I've heard of *Analog*," Laura said. "But Fleischmann and Pons mean nothing to me."

"How about cold fusion?"

"Nope," Laura replied.

"So what do people do for energy in your version of the twenty-first century?" Jeff asked.

"Pretty much the same as in the century we're in right now," Laura said. "Fossil fuel. Some solar. A little fission and fusion here and there—but fission's frowned upon because it's deemed too dangerous, and fusion barely makes it economically."

"Jeez," Jeff said. "So let me get this straight. In my reality, the Challenger takes out a schoolhouse in Miami, and the space program along with it. But the Soviet Union starts collapsing at the end of that same decade, and a universal, low-cost, safe and reliable fuel technique is discovered. In your reality, the Challenger tragedy is more limited, but the Soviet Union continues, and the world is still smarting from all the soot in the air."

"Sort of makes sense, doesn't it," Laura said. "In my reality, the Earth is more irritating, less hospitable—politically as well as physically—so there's more of a goad to get off of this planet and out into space."

"I'm not sure I like your reality so much anymore," Jeff said.

"Well, I guess you should have thought of that before you nearly sacrificed your life to alter the Challenger," Laura said.

Jeff sighed. "There's got to be a way to get the desirable elements of both."

"Maybe. Maybe not," Laura said.

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"You're trying for an alchemy of time—to create the perfect world, the ideal golden age, out of our two timelines. But we don't know if that can be done—we don't even really know what the elements, the building blocks, of these realities are. So, if anything, we're worse off than the alchemists. Maybe we should just leave well enough be now—"

"No! We've been over that already."

"Just listen to me for a minute," Laura said. "We've already changed the Challenger part from your reality to mine. So, when you're born in the twenty-first century, the Challenger will never have reached Miami. You'll be a different person in that century—with no motivation to come back and alter time. And yet you're here right now, talking to me on this phone. That means that you—the person you are now—has survived our tampering with time. And I'm here with you in this time. And we have our baby—you've already felt her inside me. Soon you'll be able to hold her. Can't we just have that? Haven't we earned the right to enjoy our lives now? Sam says that—"

"I don't give a damn what Sam says—it's none of his business!"

Laura was sobbing.

"Angel, I'm sorry," Jeff said. "You know I love you. I'm going to try very very hard not to be the one to go back—"

Laura hung up the phone with a slam.

The emptiness rang in his ear.

He thought of nothing for a few minutes.

But his mind edged, of its own accord, towards images of Laura. He could see her sitting in the back of his classroom in City College, on that very first day in 1964, him stranded in the past after the Thorne had pulled him back way too far, and Laura . . .

He called her back. "OK," he said. "I promise you it won't be me—I'll figure out a way, I'll make sure it's Yelena or someone else who goes back. Let's talk about names for the baby. . . . "

* * *

Karina slipped into an air-conditioned cab at the San Diego Airport. "I'm going to La Jolla."

The driver turned around and gave her a big, Mexican-bandito smile. "You'll be right at home there, Señorita."

"What makes you say that?"

"Ahh, La Jolla's filled with beautiful, narrow-bodied women like yourself."

"Why thank you." Karina smiled. She enjoyed the compliment, as well as the great way the cabbie pronounced La Jolla, with the guttural 'ch.'

She leaned back and closed her eyes. She figured she was safe now—or, at least, as safe as she could be, given the ever-present inherent dangers of travel in the past. Sometimes she wished she could be like other people—lie on a beach somewhere in La Jolla, thong bikini riding up her backside, ogled by decent, uncomplicated men like this cab driver. But that was not her lot in this universe. . . .

The cab pulled into La Jolla. Its streets were quiet in the dusk, much like she remembered them. Muted pinks and ochres, stucco gateways to other worlds. "When you get to California, you're at the end of the world," she recalled her mother once saying. "The only way further is up." That was true enough. California represented the end of expansion ever westward—to go any further in a conventional way was only to go back east, back to the Far East, back perhaps to some of the very origins of this humanity.

Space—outer space—was one way out. Some people thought that outer space was what everything was really all about. She had never been in outer space. But she was adept at travelling inner space—the space between years—the liftoff into time.

"Silverado Street, Señorita. Tell me where."

She pointed to the pastel grey building, and paid for her ride.

She looked for the guy singing John

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Lennon songs. He had been here the last time. *It really is*, he had sung. Yeah, it was—but what was it? Not John Lennon—he was gone, and no one could save him. His death in prime time—original time—had left too many markers. Just like JFK's. You could only change secondary things, shadows on the Platonic wall. The trick was telling which was the shadow, and which the wall.

She knew just which nondescript place on the door to place her palm upon. A minuscule scanner recognized her print. A bolt slid open. She looked around to make sure no one was watching, and quickly entered.

The inside seemed empty of people too. She hurried up to the second floor. She knew just how to elicit the time machine from its hiding place.

Its destination was already set. She pondered for a few moments. It would take her hours to recalibrate for a different arrival date—those settings were a complicated business. And she might do damage by arriving somewhere—some year—she was not supposed to. On the other hand, if the destination on this machine was already set, she might be stealing someone else's ride. Whose? George's?

Her head throbbed. "Don't get too close to the contemplation of paradox—therein lies the path to complete paralysis," George himself had always said. She thought again about George in that room, in that chair, in their cottage on the bay. She thought about that knife at his neck. "Everything's already in motion. . . ."

She wiped a tear from her eye, and started the sequence. Her arrival date would be in December. 1988, specific day and time variable, to be decided by the machine and its scan to make sure there were no witnesses to its materialization.

"So what are we going to do if this key created by your computer doesn't work?" Yelena asked.

"No problem," Jeff replied. "In that case, I'd invite Felice out to dinner. Talk her into coming back to my hotel room for a little drink. Slip her a Mickey Finn—that's the name for that here, isn't it?—and while she was in dreamland, I'd duplicate the key. Easy as a A, B, C."

"You have lots of confidence."

"Yep."

"Who was Michael Finn? A Mark Twain man?"

"Huh? No—Mickey Finn is an *it* not a *who*." Jeff laughed. "It's a drink with, you know, a sleeping pill mixed in—I thought the usage was appropriate to this decade. Or maybe it is, but you don't know it because you're Russian. You're a confusing person to be around in these kind of circumstances."

Yelena smiled. "You seem like a nice man. Would you really do that—knock a girl out with a drink just to get a copy of her key? It's hard to tell when you're joking."

Oh, I'd do much more than that, Jeff thought. I was this close—*this* close, he pressed his index finger against his thumb—to killing Nixon. As Laura always reminds me.

They reached the evening door on Silverado. No one was around. Jeff slipped in the key. Among the informational booty his intelligent agent had brought back from Landry's net was a diagram of this building's security system, including this door. That information, fed into his puterwafer and its key-making module, had produced this little celluline key. . . .

Which worked. The bolt slid open. Too bad, a satyric part of his brain noted. Felice in his bed in his hotel room was by no means the worst scenario in the world.

"Let's get upstairs," he said.

"Looks the same as last time," Yelena said, gesturing to the rows of 286 computers as they walked into the room on the second floor.

"Yeah," Jeff said. It was one week prior to the departure date that Jeff had discovered on the downloaded schedule. "There are only two possibilities here,

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assuming the schedule is right. One, the time machine is already here, camouflaged in some way. Two, if it's not here now, it has to get here some way in the next seven days, so it can be here one week from now for the departure. Its likely arrival time in that case would be in the evening, or on Sunday, when no one was around."

But the room indeed looked the same as last time, which meant there was no sign of the time machine that Jeff could see. Yelena's photographs had come up empty in that regard, too. . . .

The two stayed the night, but saw nothing. They went through the same routine for the rest of the week—up all night in the computer room, grabbing what sleep they could during the day in their hotel rooms—with the same lack of results.

"Pray it shows up tonight or tomorrow," Jeff said wearily on the Saturday night before the Sunday departure date. "If not, there's something very wrong in our calculations."

"OK," Yelena said. "But remember, I make no promises—"

"Yep, got that. I understand." But Jeff thought to himself: She makes no promises, but she's not accompanying me on this night after night because she's not intrigued on some level about the time-travel possibility. Take my hand, I'm a stranger in paradox. . . . More than intrigued. Likely consumed—as Jeff had been, back in the 2080s, when he'd first been drawn into this, into that cool orange continuum of a control room. . . . The sherbet room, Rena or someone on his team had dubbed it. . . .

"Jeff!" Yelena whispered sharply.

He focused his eyes on the present, on this room with its ancient computers before him, and saw someone walk in on the far side. He hadn't even realized that line in the wall was a door. . . .

It was Landry!

Yelena looked at Landry, her eyes wide open. Those eyes suddenly looked a tiny bit familiar—this was the first time Jeff had seen her with that expression . . . He put his index finger up to his lips and caught her attention to indicate silence.

Landry did something with one of the computers that seemed to turn the others on. Of course, they were networked—Jeff knew that already. He had searched and searched for some indication of a time machine.

All of these 286s—there were more than twenty of them—functioning as one integrated unit could be powerful indeed. If Landry had a tiny amplifier in his hand that made their combined computing power exponential, rather than additive or even multiplicative, the resulting capacity would be extraordinary. There were already desktop exponential combiners in Jeff's time. Landry no doubt had access to much more. . . .

But extraordinary capacity for what? Surely not enough to haul a person through time. All the computing power in the world could not in itself create an artificial wormhole. . . .

Landry pulled something out his pocket. It looked vaguely like Jeff's puterwafer, except even thinner, more sharply delineated, smoother. Landry waved it around, like a magic wand. Obviously, it was communicating in some way with the 286 network, operating in tandem with it.

Jeff realized that his intelligent agent and his puterwafer, for all of their sophistication, had done little more than capture what was on this network, hold its shimmering information in their arms. Landry's wand was making love to it. The screens of the 286s pulsed in synch with his swaying hand, their innards seeming almost to hum in accompaniment and contentment.

And out of this procreation something indeed took shape. At first, Jeff wasn't quite sure what he was seeing—he'd never seen a time-travel machine from this end, on the outside looking in, neither his Thorne nor Landry's fancy device, as he'd made his two previous journeys.

It came like something out of the rain. A shiny new car fast approaching in a

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blinding grey-white storm, a sleek silent helicopter in a hurricane. . . . Except the glimmer had nothing to do with water. . . .

Where had Landry been keeping it? Surely these computers, powerful as they now no doubt were in exponential synergy, had not just created this machine on the spot out of atoms in the air.

No, of course not. The answer was obvious.

Landry must have had this machine—and perhaps others like it—not someplace else, but some*time* else. In another month, another year, who knows, another century—in this place—to be called back to this time, or whatever time Landry was in, by a remote command generated by this computer network now in amplified high gear. A signal would be intrinsically easier to send through time than an object. Light, electricity, whatever the format of the information, weighed nothing.

Jeff's original Thorne, as far as he knew, had no such automatic feature—it required a human pilot to make it work. But Landry's machine was far more than a Thorne.

Jeff became aware of Yelena squeezing his hand.

Landry was approaching the machine—clearly the same sleek module Jeff had taken from 1972 in 1986, in this very place.

Time to find if Jeff could put a new little rewind into time.

"Hello, George."

Landry wheeled around, startled. "Who the hell are you?"

"Don't tell me you don't know who I am," Jeff said.

"I don't, but if that's what you want, OK, I won't." Landry looked at the small stun weapon Jeff was pointing at him. "I certainly know just what *that* is, though, if it makes you happy."

"Well, that's something." The truth was that Jeff's little stun-gun, which he'd brought along in his suitcase from the future in his unintended trip back to the 1960s, had never worked back here. Jeff had tried it on a squirrel or two in the park, even on the neighbor's cat once, to no avail. Fortunately, Landry couldn't know that.

"So, I gather you're not from around here originally," Landry said, still looking at the weapon.

"You really *don't* know who I am, do you?" Jeff asked. Landry might have looked a little younger than Jeff remembered, and so for Landry this experience might be happening prior to what Jeff thought was their first meeting—in Washington, in 1969—but Jeff wasn't sure. He hadn't seen Landry all that many times, and when he had, the circumstances were so trying—

"Look," Landry said, "I can't prove to you that I don't know you—I could be feigning ignorance—how can anyone prove that they're not? So let's get to the more important question: You're obviously from the future. You obviously know this is a time machine. You've obviously used it or something just like it to get here. What the hell do you want?"

Jeff raced through his options. He hadn't expected to find Landry here. Perhaps this opened up new possibilities . . .

"Let's start by your telling me just where you're going in that," Jeff said.

Landry shook his head no. "Sorry. I make it a point never to reveal destinations. As a time-faring man, you no doubt understand why—our work is complicated and dangerous enough, without expanding the circle of people who know what we're doing."

Jeff brandished his weapon.

Landry laughed. "Come on. You're not going to use that if you want information from me. Unconscious people are very uncommunicative."

Jeff tried to stare him down.

Landry made a sarcastic sound, turned around, and took a step towards his machine.

"I *will* render you unconscious if you take another step in that direction," Jeff said quietly.

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Landry turned to face Jeff again. "OK, that's progress. Part of what you want here is for me not to go into that machine. Why?"

"I want the ride myself."

"Ah, I see," Landry said, his eyes lighting up. "And what happened to your machine?"

"Long story," Jeff said, "assuming you don't already know it."

Landry smiled. "And you expect me to just turn over my machine to you—not having any idea what you intend to do with it? You really think I would do that, given what I've just told you about how serious all of this is?"

"Sorry, I can't tell you what I'm going to do with it either—" Jeff began.

"He wants me to go back in time and change a crucial event or two in our country," Yelena said, revealing herself for the first time.

Jeff turned around to tell her not to say anything more, then noticed she too had a weapon in her hand. Except it was the old-fashioned kind—a pistol, which fired bullets, the kind that ripped into your heart or brain.

"Yelena, what are you doing?" Jeff demanded.

"I brought this along in case a situation arose," Yelena said. "I think one has arisen—"

Landry made a dash to the time machine.

Yelena fired a single shot that went clean through the baggy edge of Landry's trousers.

Well, that at least answered one of the questions Jeff had—unlike his weapon, Yelena's worked.

Landry stopped, shaken but apparently unhurt.

"The next one will hit flesh and blood, I assure you," Yelena said. "Maybe even your balls."

"Jeez," Jeff said. "Who the fuck *are* you?"

"Never mind me," Yelena said. "This man you call George Landry is KGB."

"What?" Jeff asked.

"Absurd," Landry said.

"You deny that I saw you at the University of Moscow in 1987?" Yelena asked.

"I thought you've been here in the United States since 1986," Jeff asked Yelena.

"Yes, I was in Moscow in 1987, but that doesn't make me KGB," Landry said.

"I'll soon find out the entire truth, with my own eyes," Yelena said, and began walking towards the machine.

Jeff looked at her eyes again, and again saw something, some flicker, of deep familiarity there—

"Don't let her do it!" Landry shouted at Jeff. "You've got the damn stun-gun, use it!"

Yelena sneered. "It's a toy."

Landry erupted, lunged towards Yelena. She stepped back, coolly leveling her gun at Landry's head. "Walk away from me," she barked. "Last chance."

Landry backed off, shuddering with fury.

"Yelena, please—" Jeff began.

"Don't worry, don't worry—I'll take care of everything," she said. "It was good to see you again." She smiled and entered the gleaming machine.

Its doors closed a split second later. And a split second after, it disappeared in the same glimmering almost-rain that had delivered it into this room.

"She used the preset destination," Landry muttered, still shaking with anger. "No other way she could have gotten out of here so fast."

"And just when is that?" Jeff asked, throwing his worthless stun-gun on the floor in his own frustration.

"December 1982—a month after Andropov takes over. I was trying to go back to stop that."

It was February—1989—when Karina finally arrived in New York. She shivered. Much colder than La Jolla.

"Thirty years ago today Buddy Holly died," Bob Shannon said on CBS-FM Radio. But who was Buddy Holly?

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She settled into her room on Patchin Place, in the Village. "A prime sublet," the agent had told her. "A science fiction writer usually lives here—lots of interesting books you can read, if you don't get ketchup on them."

She'd earned enough money waitressing in La Jolla—in two different restaurants, almost night and day—to keep her going here in New York for at least a few months.

She considered her options, and warmed her hands with a hot cup of tea. Its steam felt good in her face.

She picked up the phone and called Sam.

"Karina! Where are you?"

"Here in New York."

"Yes—you sound close. Wonderful! Where's George?"

"I . . . I don't know. I left him in 1991." She started crying.

"Are you OK? Is George—"

"I don't know," Karina sobbed.

"Oh my God, that's what I was afraid of. What happened?"

"I don't know," Karina said again, helpless, for the third time. "He had in motion a plan to kidnap Andropov, threaten to kill him, kill him if he had to. Chernenko's been dead since 1985, so Gorbachev would have taken over. . . ." She was crying again.

"Yes, I know," Sam said as gently as possible. "What went wrong?"

"Everything, everything! A hurricane on Cape Cod—in the summer, two years from now—cut him off from his contacts. Some people found us at his cottage—I'm sure they were KGB. I think they killed him—"

"George is a resourceful man. Don't count him out. Remember the way Dick Atwick fooled us all and survived? George is far superior."

"I know," Karina said, "but . . . you didn't see him. And . . . Andropov's dead—I'm sure of that. I heard it on the radio before I left 1991. And his successor's no Gorbachev—it's Vladimir Zhirinovsky, that Nazi."

Sam gasped. "He's not much older than you. That's what happens when we let these things get out of our control. I told George: you've got to stay on top of these things, beat by beat. . . ."

"It wasn't George's fault," Karina said. "I told you—we had a hurricane."

"I know, I know, it's no one's fault," Sam said, sincerely. "But this is a grave situation—or will be, in two and a half years. We've got to figure out, the two of us, what can be done to prevent it."

"I don't know if I can do this anymore," Karina said. "That's the main thing I called to tell you. And . . . I found some old papers in George's cottage. They say my mother's in New York now. I—I want to see her."

"I don't think that's wise at this moment," Sam said.

"I don't care anymore about wise."

"Look, I know you don't trust me," Landry said, "but the only way I can see out of this is for both of us to lay our cards out on the table."

Jeff had consented to a late dinner with Landry at the Valencia. The waiter now brought their poached salmon to the table.

Landry tasted, and made a face. "Not very good," he said. "I guess the future has spoiled me."

"Yelena loved it," Jeff said. "She said it was very fresh."

"Not surprising," Landry said. "Compared to what they serve you in Russia, a piece of stinking tripe over here would seem fresh."

Jeff shoved a piece in his mouth, washed it down with wine. "All right," he said. "Here's the world I'm trying to create for the twenty-first century: a vibrant space program, democracy in Eastern Europe, and, oh yeah, Fleischmann and Pons take off with cold fusion."

"Who?"

"OK, never mind about them."

"I'm with you on the other two," Landry said. "That's the world I'm after too: strong space, no Soviet Union. But

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as you may have already discovered, that's a hard play. The Soviet Union was, after all, as much responsible for humanity in space as the Nazis and the United States. Maybe even more so—Sputnik, Gagarin, they were crucial in picking up the lead of the Germans, and egging the US on. Von Braun was already here in the US, but without those Soviet accomplishments, JFK would have been much less willing to follow Von Braun's inspiration. And the Soviet Union did lots of good in the twenty-first century too—Mir2, the Red settlements on the Red Planet, the Oort stations in the 2090s . . ."

"A little ahead of my time," Jeff said. "In fact, even *in* my time, in the twenty-first century I come from, we have no space program and no Soviet Union. I assume the reality you're talking about has strong space programs in both the US and Russia—I mean, in the Soviet Union."

"Right," Landry said, "Europe and Japan as well. But I agree with you that the world would be better off with a strong space program spearheaded by the US at the end of the twentieth century, with ensuing worldwide involvement—and no Soviet Union in the twenty-first. But it'll be a tricky business bringing that combination about."

"Well, maybe Yelena—"

"Forget it," Landry said. "She's on the other side. If anything, she's going back there to strengthen Andropov's hand—to see to it that he lives at least another decade."

"How can you be sure?"

"She's already back there, right? If she'd succeeded with *your* plan, Gorbachev would be in power right now—not Andropov. It's March 1989, right? Hold on." Landry turned to a passing waiter. "Who's the Premier of the Soviet Union? Can you tell me?"

The waiter shrugged. "I don't know. Lenin? Nikita?"

Jeff and Landry both waved their hands in disgust.

Another waiter, who had been listening, came over, laughing. "It's Yuri Andropov, right? Hey, there's an article about the Soviet Union right here in the paper. Says Andropov spoke out today about the execution last month of Boris Yelstin. He said there was no place for capitalist sympathizers in the new and improved Soviet Union. . . ."

Jeff looked at the paper and shook his head, sadly.

"Thank you," Landry said to the waiter.

"Sure," the waiter said. "Hey, you can keep the paper."

"Thanks," Landry said. He turned back to Jeff. "Satisfied now?"

"Hardly satisfied," Jeff said, "but I get your point." He pushed his food away, mostly uneaten. "The salmon wasn't that bad," Jeff said, "but that news story made me lose my appetite."

"I don't blame you," Landry said.

"So what do we do now? Yelena took our time machine."

"Suppose I told you I had another one?"

Lord, the streets of New York were cold in this century. She was afraid to look at anybody too carefully, lest they take offense, or mistake her gaze for an expression of sexual interest that she wasn't in the mood for just now. . . .

But Karina couldn't help but stare at everyone she passed, scrutinizing their faces, assessing their eyes for some sign that they were of her kind.

Her kind . . . What kind was that? Someone born out of time, conceived in one century, gestated in another, raised in a third. "You're three centuries old," George always had teased her, especially when they lay in bed together after making love, him running his fingers down the small of her back, giving her one last chill. God, she missed him. He was old enough to be her father in biological age—but what did that mean to people like George and her? He was the only man she'd ever known who really understood her. The only man she'd ever felt truly at ease with.

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She didn't feel at ease with Sam. She didn't really trust him. She'd declined to meet him in the ten days she'd been here. She dyed her hair and cut it so Sam would have trouble recognizing her if he'd decided to press the point.

Her kind . . . The theory was that a tumble through time had no adverse affect on the fetus. But as long as she could remember, she had always felt on the brink of paranoia when she contemplated what was going on around her. Except when George was around.

Her mother would understand. She was a child of time herself, in her own way. It had been ten years since Karina had last seen her. She didn't even know her name anymore—names changed too quickly in this business. But Karina had an inkling, based on those papers on the Cape . . .

She stopped at the NYU Student Union Building. God, the history here! Her eyes looked up, and sought out that student lounge, as they always did when she walked by this corner. . . .

But the path to her mother lay elsewhere today.

"Excuse me," she said to a security guard, who looked like Charles Manson in a uniform, lounging against a lamppost. "Is that Tisch Hall over there?" She pointed to a likely building.

Manson smiled and nodded, revealing a set of teeth that looked like late Mayan maize.

"Thanks." She hurried off. Her breath felt sticky in her chest. The talk would begin in about twenty minutes.

"I had three machines in stasis—preset for 1982, ready to be called into service here—when we started this escapade a few hours ago," Landry said. They were back on that second floor of the pastel grey building on Silverado. "Yelena the Great took one. I propose to call forth a second, and take it back to 1982 myself to see if I can accomplish what she either failed to or more likely deliberately prevented."

"How can I be sure you'll do as you say?" Jeff asked.

"Because I'm going to give you one of these little eels—much more powerful than your wafer—and show you exactly how to call forth the third machine, in case you need it."

And Landry did just that.

"Allow a minute or two for settlement after I leave," he continued. "You know the drill. Call up the local radio station—here's their number—"

Jeff frowned.

"—so, get the number yourself then, if you still don't trust me."

"OK, I trust you," Jeff said. At least, I trust you at this point more than I don't, he thought. And what other choice do I have?

"Good," Landry resumed. "And if the radio station tells you Comrade Drop-off is still head of the Soviet Union, you'll know what to do—go back to 1982 and give it a shot yourself. Maybe the two of us will prevail over Yelena—or over who knows what else back there."

"You don't seem all that confident," Jeff said.

"Confidence? No such thing in this line of work—you should know that."

"Yeah, but I don't speak Russian," Jeff said. He was also thinking of Laura, and their baby.

"Not to worry, most of the important people over there still speak English. It gets much worse in the next century, of course, if we're unable to change this—they were speaking Russian in northern Canada already the last time I was there in 2060, for crissakes. . . ."

"OK," Jeff said. "I get the picture." Laura would never forgive him, he was sure. What he wasn't sure about is if he could ever forgive himself if he left her again.

"All right, buddy—I'm off to the races, then." Landry walked towards his machine. He turned around. "You have a look on your face that we'll see each other again—you obviously recognized me when you laid eyes on me here a few

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hours ago. Since that was the first time for me, this obviously means that we'll be meeting again later in my life, earlier in yours. I'll try not to upset you unduly then—give too much away that we'll be meeting again in your future. I'll make it hard for you—play the hard-ass to your neophyte—to make it easier for you." Landry smiled. "But you already know that. Till the next time, then—whenever it may be!" And he walked into the machine.

It disappeared in the silver-grey pseudo-rain.

Jeff didn't have to call the radio station—he could feel the lack of change in his bones, the stasis of standing in an elevator when it should have been moving but wasn't. Or maybe worse—moving down when it should have been moving up . . .

He called the station anyway. "Yeah, right, thanks." Yuri Andropov was now not only General Secretary of the Communist Party but President of the Soviet Union, as of March 22, 1989.

Jeff looked at the remaining machine, his mouth dry. There were dozens of good reasons he could think of for not going. Yelena and now Landry had failed to turn the Red tide, why should he do any better? And there was Laura, Laura, Laura, Laura . . .

And there was just one good reason he could think of that he had to go, one goddamn worm that wouldn't let go of his insides: this world with the Soviet Union ascendant, this world that he had perhaps somehow even unwittingly midwived into being with his Challenger tinkering. It was unacceptable—it wasn't meant to be.

He took a step towards the machine, and stopped. He took another unsteady step—

"You're not going to break your promise to me, are you?" Laura's voice asked, in his head.

"I don't want to," he said aloud.

"Then don't," Laura's voice said.

Not in his head.

He spun around.

"My God—how long have you been here?"

"Long enough to hear the little chat you and George had," Laura said.

"I was thinking of you—and the baby," Jeff said. He looked at her. She looked more pregnant now than the last time he had seen her. "Are you OK? I mean, the both of you . . . "

"Oh, we're fine," Laura said, and patted her midsection. "The plane ride was smooth—though I bet they were glad to get me off the plane without a special delivery."

Jeff smiled, weakly.

"You know, you didn't mention to Landry the most important reason that going back to 1982 to kill Andropov or whatever you expect to do back there is a bad idea," Laura said.

"I—I didn't feel comfortable talking to him about you and our baby—" Jeff began.

"That's not the most important reason," Laura said.

Jeff looked puzzled. "What, then? That murder is bad? We've been over that already, with Nixon. You and I don't see things exactly the same on that."

"No, not murder in general. Murder of *Androhpawf!*" Laura said. Her voice had an odd intensity—an odd accent—that Jeff had never quite heard before.

"Ah, I see you're beginning to understand now," Laura continued.

"You said you loved me," Jeff was barely able to speak. "That's our baby—"

"I do, and she is," Laura said. "But you loved me too, and that didn't stop you from doing what you needed to do to save the Challenger, remember?"

"Yes, but—"

"And your loving me, and the baby—would that have been enough to stop you from going back to try change things in the Soviet Union even now? You were about to walk right into that machine and leave us behind, weren't you?"

"I hadn't made up my mind and you—"

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"The Soviet Union is a great country," Laura said. "*My* country—the country of the twenty-first century. Of the world! Of space beyond the world! We launched the Sputnik! We had the first living organisms in space—and then the first man to circle the globe! We had our losses too—three brave cosmonauts died in Soyez 11! But we pressed on in space. And we do great things in the next century! If we're allowed to continue—"

"But Andropov's a murderer," Jeff argued. "You don't believe in that—I know you."

"I believe in sacrifices, tradeoffs, weighing the choices that sometimes have to be made," Laura said, her eyes wet with inspiration as well as sorrow. "I stopped you from killing Nixon not because I was so much against murder, but because Nixon alive was helpful to my country—we needed Nixon so Brezhnev would react against him, cooperate with him—Nixon was the perfect American for my country!"

"No! I don't believe it," Jeff insisted.

"Believe it," Laura said. "And believe that, yes, I do love you." And she stepped into the machine—a second before Jeff realized how close she had moved to it, a second too late for Jeff to do anything about it.

He tackled the machine, but all he got in his arms was the rain that wasn't wet.

His body was soaked with perspiration anyway, his face slick with tears.

Laura was gone.

And Jeff knew, not only that he might well never see her again, but that she was going back to 1982 to stop Landry and Yelena—to make possible the very Soviet dominance of the twenty-first century that he had been trying so hard to prevent.

That, Jeff understood at last, after all of these years, had been her ultimate mission. Her real reason for tracking and meeting Jeff in 1964, maybe even for staying with him all of this time, even after he had left her. Just as his had been to save the Challenger. She had helped with that because a vibrant American space program was a good source of competition, a powerful stimulant, to the Soviet space effort in the twenty-first century.

"Karina? I hardly recognized you, with that new hair! Good thing the call of nature brought me back here!"

Karina had been concentrating on the talk from the back of the auditorium, eyes dilating with every word. She turned to face the intrusion, and her eyes dilated even more—with a different emotion. "Sam!"

He smiled. "Come." He put an arm around her. "Let's go over there." He gestured to a descending flight of stairs outside of the auditorium. "I think we can find a bit of privacy there."

She hesitated, not wanting to leave the talk. But with Sam right here . . . "OK," she said, and reluctantly allowed him to lead her to the staircase.

"You know, I told you this wasn't a good idea," he said, when they'd settled in, a half flight down, backs against the wall. "Meeting people you're not supposed to, unexpected intersections in time, they can cause trouble, *big* trouble. You see, we have no *record* of your being here, of your meeting your mother in this time and place. That's the problem."

"Stop talking to me like a child," Karina snapped. "I know about trouble. I saw George—"

"I know, I know, believe me," Sam said, as soothingly as possible. "But whatever happened to George two years from now—and, again, we can't be sure, he may still turn up OK after all—there's surely no point in making things worse by twisting up the threads back here; in 1989. Surely you see that?"

"My mother's the only thing I can see," Karina insisted. "I'm sick of this time-travel depravity—I want a normal life, a family, my parents, a husband someday—people weren't meant to live like this! Jumping around through time, crossing wires, tying their souls up in

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knots to the point of not knowing who or where or when they are when they take the simple human action of looking in a mirror? It's enough already! I'm going to meet my mother, tell her the truth of what I've been through, what the future has in store for her—"

"Of course you will, my dear." Sam had removed an embroidered handkerchief from his vest pocket while Karina had been talking—one he always carried for occasions such as this. Now, without the slightest warning, he put it over her face and nose with one hand, and brought the other around the back of her head, pressing her face into the handkerchief, so that she was utterly immobile. The chloroform derivate worked almost instantly. Within fifteen seconds she had crumpled into his arms—in fifteen more she was utterly unconscious.

He propped her head up as gently as he could against the wall. He lifted her left eyelid, and looked at her pupil—ring of sweet chocolate, dilated, unseeing. Unremembering too, he hoped—though that was not sure a thing with this quick-acting drug. He let the eyelid droop slowly closed, and kissed her on the forehead. "Of course you will, my dear—of course you will."

He walked quickly up the stairs and out of the building, and summoned the security guard on the corner. "There's a girl who seems to have passed out on the lower staircase," he told the guard. "She may need some medical attention."

The guard bared his stained teeth. "Drugs, goddamn drugs," he said. "These kids are killing their goddamn mortal souls with those drugs."

Sam nodded sympathetically, then hurried back into the auditorium. Yelena's talk was just ending. Jeff was already applauding. Good—everyone would be out of the building and long gone before Karina awoke.

Jeff walked up the stairs of his East-side brownstone. He hadn't felt so utterly alone, so entirely out of place, since he had first set up residence here after his stranding in 1963.

The news on the TV was uniformly depressing: no Chinese students in Tienanmen Square, no sign of Gorbachev anywhere. And May was even worse: Yuri Andropov further consolidates his power by crushing the rebels in Afghanistan for good. . . .

Well, at least the US space program seemed somewhat back on track. A report said six shuttle launches were planned for 1991. . . .

Jeff shut off the TV and tried to call Sam. Same result: his phone machine said he was out of town.

Jeff took the subway down to NYU. Sometimes, when he was half asleep, rocking to and fro with the train car, he felt as if he were a hundred years in the future, back where he belonged . . . back where, if he opened his eyes, he was sure he would see the soft holographic ads all around him, the mirrorims of products new and bold, the smooth smiling service that only robotic engineers could render. But when he opened his eyes, the ads and the people were always garish, dirty, two-dimensional—the ubiquitous greeting card of the twentieth century.

He walked around Washington Square, and day-dreamed of Rena. He thought of Laura, and yearned for his baby. But all he saw were the faces which seemed to look at him as if they knew him, even though he knew they did not.

He pondered his situation. There had to been some logic, some path he could follow to influence events. He'd tried to call forth more time machines in La Jolla, but Landry had been telling the truth when he'd said there were only three. Worse than that, the schedule he'd downloaded from Landry's network revealed no further arrivals or departures at later dates. It was as if, with Laura's departure—back to 1982 and the Soviet Union if she was telling the truth—

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Landry's whole time-travel project had concluded, vanished.

But there had to be others.

Something had to have been the source of all the time travellers to 1963 that had caused the JFK vortex that had pulled him back to the 1960s in the first place—assuming, of course, that he and Laura had been right about that.

Laura . . . the key was with her. He still couldn't believe that she was a Soviet communist, bent on keeping that system in place through the twenty-first century. He knew her. She believed in freedom. Maybe she would have a change of heart back there, and help Landry after all.

But if she had, wouldn't Jeff have seen the evidence already? All he saw was Andropov.

Still, he looked through Laura's papers. She had left New York to fly to La Jolla in a hurry. Lots of half-scribbled sheets were still around. . . .

He came upon a sheet with doodles and names. Jeff smiled and grimaced at the same time, crumpled the sheet in his fist and put it under his heart. The names were the ones he and Laura had been discussing during one of their phone calls—possible names for their baby.

Jeff uncrumpled the sheet and looked at the names. Some were the ones they had talked about. Names based on parents and grandparents and ancestors . . . names based on no one's names, just names they liked . . . and there were some names that Jeff hadn't recalled Laura mentioning . . .

At the bottom of the sheet, two names were circled, with arrows pointing to penciled explanations.

"Karina" ➔ "because my favorite grandmother was named Karen, and because I think a part of Jeff still loves Rena" . . .

"Yelena" ➔ "after Jeff's grandmother, Eleanor, who was Eli Harris' wife" . . .

And then, in smaller letters on the righthand side of the sheet: "Karina Yelena Harris" ➔ "because our daughter should always know she is Russian, whatever may happen".

My God, Jeff hugged himself and cried: I lost my daughter not once but twice to those cursed machines in La Jolla. . . .

He taught classes in the 1989 summer session at NYU—mainly so he could be closer to the streets around Washington Square Park. He felt more at home there these days than at home. It was easy to get a job at NYU, with his forged credentials ratified now by real teaching spanning decades.

One afternoon after his class, a student was waiting for him outside his office.

She looked familiar, but he'd learned not to get too excited about that. He let her in, and bade her to a seat.

"Would you like admission to one of my Summer II classes?" He pulled out a pen and looked for an admission form. "I'm too egotistical to ever refuse a student willing to pay money to hear me talk."

The student laughed. "Actually, I was hoping you could admit me to your life, now that I've finally found you."

"Oh?"

"I'm pretty sure I'm your daughter."

The pen fell to the floor.

"I've located another time machine," Karina continued, "and I think I know how to get Gorbachev back in power. . . ."■

*This novelette continues a series by Paul Levinson that began with "Loose Ends" (*Analog, *May 1997) and "Little Differences" (June 1998). Dr. Levinson is also well-known for his novelettes featuring NYC forensic detective Dr. Phil D'Amato. Further exploits of Phil D'Amato appear in Paul Levinson's first novel,* The Silk Code, *just published by Tor Books.*

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William Walling

YOU ARE HERE!

The Global Positioning System has made navigation trivially easy for everyone from hikers to pilots—but behind that apparent simplicity lies a huge amount of hard, complicated work and ingenuity.

Or are you?

The sign is posted in shopping malls, amusement parks, and business complexes, usually in the form of a stylized map with an arrow pointing to "X" marks the spot. Yet underlying the sign's ubiquitous reassurance is a question laced with philosophic overtones: How do you really know "here" is where the sign says it is?

Overview

During ancient Polynesian and Melanesian migrations, hardy voyagers crossed thousands of miles of open ocean in tiny outrigger sailing canoes. Steersmen prayed for clear weather, reading the currents, winds, and the sun's position in the sky by day, the gleam of certain fixed stars at night. Viking wanderers probably used the same haphazard methods.

Columbus's epochal voyage revived a truism denied by ignorance and superstition since Roman times: the fact that our planet is roughly spherical, not flat, putting to rest the fear of sailing off some nonexistent "edge." Eleventh century Mediterranean and Chinese navigators began using crude magnetic compasses. The Magellans and Drakes had it easier, obtaining guidance from the astrolabe and octant. Eventually a chronometer accurate enough to determine longitude was developed in England, then in the eighteenth century the octant evolved into the sextant. But prior to the advent of high-tech navigation aids like LORAN, the radiocompass, gyrocompass and allied inertial systems, sea navigation demanded specialized expertise.

Surveying underwent similar growth pangs. To level the Great Pyramid's base, archaeologists tell us Nile water was poured into checkerboard cavities hewn

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into the stony outcropping upon which the stupendous man-made mountain rests. Using a naked-eye sighting device, the *groma*, Roman legionary engineers laid out a sophisticated network of empire-spanning roads, bridges, and aqueducts, portions of which survive today. Later, spirit level and transit gave way to the theodolite and optical total station.

GPS, GIS & LIS

Contemporary technology rarely slackens in pace; it tends to accelerate. Milestones deemed state-of-the-art only yesterday turn obsolescent. Landsat and other optical/infrared/radar remote sensing devices provide orbital and aerial data to Geographic Information Systems (GIS) and Land Information Systems (LIS) in support of mapping and allied studies that directly affect the planet's health, wealth, and well-being. Yet a vital precursor to GIS or LIS in ecology, meteorology, agriculture, archaeology, demographics, and other diverse fields is the rapidly growing Global Positioning System (GPS) technology. A synergistic relationship exists between GPS and GIS/LIS. GPS provides accurate 3D positioning data to academics and professionals working in many scientific and environmental disciplines, while multiple GIS/LIS feedback loops demand ever more precise position solutions from GPS.

In 1973 the U.S. Department of Defense (DoD) mandated the multiservice NAVSTAR (**NA**Vigation **S**atellite **T**iming **A**nd **R**anging) Joint Program Office to direct the development, production and orbital maintenance of a 24-satellite GPS "constellation," plus spares. Injected into staggered, 12-hour circular orbits at an altitude of 20,200 km, these satellite vehicles (SVs) provide all-weather, line-of-sight access to between five and nine GPS SVs above the horizon at all times in either hemisphere. An order-of-magnitude advancement over classic survey and navigation methods, GPS precisely radio-measures the distances and geometric configuration of artificial "stars" with known vectors, velocities and times of passage. Once an exclusive military endeavor, with monitoring and uplink stations scattered around the globe, the GPS Master Control Station in Colorado Springs uses cesium atomic clocks, plus a hydrogen maser clock, for ultra-precise timing control.

The downing of Korean Airlines Flight 007 for allegedly encroaching upon Soviet airspace—a tragedy attributed to navigational error—caused the DoD to rethink military exclusivity. GPS was partitioned into a restricted version limited to military/government usage, and a less accurate version thrown open to international civilian use free of charge, but with two "catches." DoD intermittently exercises "Selective Availability," purposely corrupting coded transmissions with random signal "dithering" to induce erroneous timing and orbital ephemeris data (time-of-passage and timing information for individual SVs). Other coded transmissions ("P1 & P2," modulated on distinct carrier frequencies) are also corrupted into classified "Y-Code," the end result of DoD's encryption during periods when "Anti-Spoofing" is activated to prevent potential hostiles from generating bogus codes designed to send false position data to U.S. field personnel. These DoD processes nominally degrade civilian effectiveness to horizontal (curvilinear) position accuracies of roughly 100 meters, and height accuracies to about 150 meters. Ingenious, applied private sector scientific and engineering techniques mitigate or circumvent these detrimental effects, but more on that later.

Now then, what nitty-gritty geodetic and spatial mechanics are involved in plucking 3D position solutions out of the sky while standing still or moving about anywhere on land, sea, or in the air? A simple question, yet the answer is both as straightforward as keying a GPS receiver and logging the displayed data,

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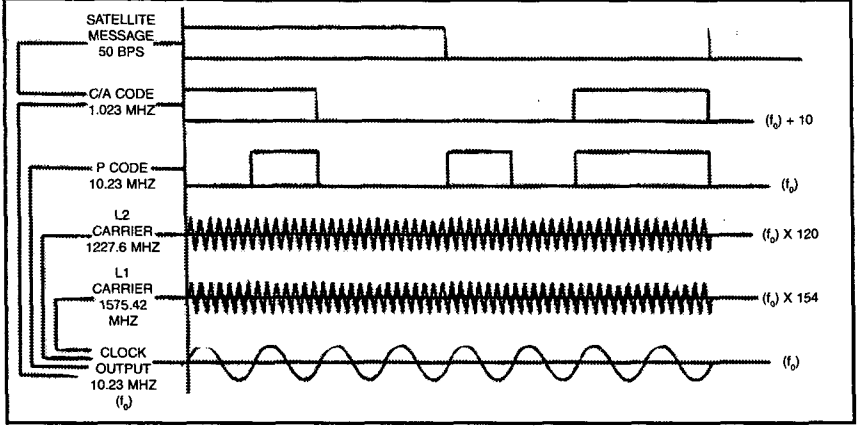
Figure 1 GPS Signal Transmissions



and as complex as the symbolic logic used to describe and manipulate the underlying principles of physics.

GPS Receivers

Numerous types and grades of GPS receivers crowd the marketplace. Low on the list are single-frequency, multiplexing, handheld or vehicle-installed units used by hikers, boaters, hunters and other outdoorsmen. These relatively simple units require externally generated SV timing and trajectory information, and provide only rough-order-of-magnitude 3D position solutions. At the high end of the spectrum are professional GPS systems used for realtime air, land and sea navigation, precision photogrammetry (aerial mapping), land boundary survey, cadastral survey (for taxation purposes), hydrographic and bathymetric survey, earth movement sensing, et al. These high-technology systems are phenomenally accurate in all three physical dimensions: X-Y-Z Cartesian coordinates translatable into curvilinear latitude, longitude and elevation through standard geodesy formulae, as well as a critical fourth dimension—time. This discussion will limit itself to the latter type, basically an antenna linked to a "black box" enclosing an array of microprocessor-driven electronics and firmware, with an "all-in-view" liquid crystal display that portrays multichannel SV data concurrently with signal detection and tracking. GPS transmissions consist of:

- Carrier frequencies.
- Ranging codes.
- Satellite navigation messages.

Orbiting cesium and/or rubidium atomic clocks of exceptional stability oscillate at the near-perfect frequency produced by electromagnetic waves generated or absorbed in the transition of atomic particles between energy states, sustaining a probable ±1 second error over a million-year period. This pure sine wave output in the L-band spectrum (10.23 MHz) is so exact that it experiences relativity effects when passing through the ionosphere. The constant 10.23 MHz output is multiplied to produce two distinct carrier frequencies: L1 at 1575.42 MHz; and L2 at 1227.6 MHz (**Figure 1**). Modulated within these frequencies are two ranging codes: "Clear Access" or "Coarse Acquisition" C/A Code modulated only on L1, and "Precise" or "Private" P-Code modulated on both L1 and L2.

Each SV transmits a unique identifying C/A Code sequence consisting of bi-

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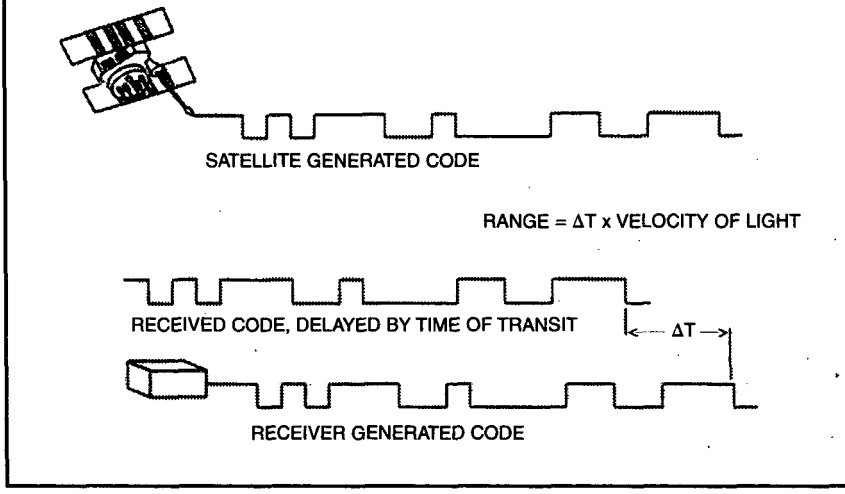
Figure 2 Satellite/Receiver Clocks (C/A Code) Aligned with GPS Time


SATELLITE GENERATED CODE
RANGE = ΔT x VELOCITY OF LIGHT
RECEIVED CODE, DELAYED BY TIME OF TRANSIT
ΔT
RECEIVER GENERATED CODE

nary "chips"—square wave pulses 1,023 bits long, with each bit indicating a 0 or 1, and an even balance of 1s and 0s in the overall sequence. Transmitted C/A Code repeats once each millisecond, and has a low cross-correlation value; this means a GPS receiver can identify and lock onto a particular SV by electronically "autocorrelating" *only* when the respective C/A Codes are perfectly aligned, thus concealing a secondary modulated message from receivers unable to reproduce identically matched, repetitive binary sequences.

Detecting an extremely weak 20-Watt signal (comparable to the output of a 20-Watt light bulb) on any quiescent channel, a GPS receiver will cycle through the C/A Code identities, find a match, search to coordinate and lock onto the timing signal, then synchronize internal receiver time (generated by a simple quartz oscillator) with the satellite's ultra-precise timing signal. This synchronization allows a measurement of each satellite-to-antenna distance (preliminary ranging data termed "pseudo-range") by means of a "stopwatch" computation, where range equals the transmitted signals' unvarying speed-of-light velocity (300,000 km/sec) multiplied by the critically timed interval between transmission and reception. A one-nanosecond time shift therefore nets roughly 3 decimeters (≈12 inches) of pseudo-range, one-microsecond 300 meters (≈984 feet), and a full millisecond 300 kilometers (≈186 miles).

While C/A Code exhibits dual properties (SV identity and this initial element of ranging), it carries no information per se; it's a simple sequence of 0 & 1 bits modulated only on the L1 frequency and termed "pseudo-random noise" (PRN) Lacking PRN, weak GPS signals would be undetectable from r-f background noise. The "pseudo" comes about because of apparent ionospheric signal delay—intermittent, unpredictable effects produced by ionosphere dynamics that "bias" or offset a receiver's quartz clock in relation to the steady-state timing signals emanating from observable SVs. A faulty evaluation ensues, resulting in erroneous ranging data. If based solely on a single atomic clock source rather than

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two or more, signals received from three SVs would suffice for basic X-Y-Z position computations. As it is, clock offset (biased timing error) forces the need for an additional pseudo-range measurement from, at minimum, a fourth SV. A receiver's algorithms must therefore solve for four unknowns rather than only three: Cartesian curvilinear (X & Y) coordinates, height (Z), and (T)—not time itself, remember, but clock offset (**Figure 2**).

P-Code Ranging

P-Code, modulated on both the L1 & L2 frequencies, is intermittently encrypted by a classified DoD process into Y-code, and transmitted at 10.23 MHz in week-long segments. P-Code (or Y-Code, when encrypted), also exhibits dual properties—SV identity and an element of ranging—but identifies individual satellites in a different manner: by recognizing a particular satellite's Julian, week-long segment of the overall binary sequence. Here, "Julian" requires an explanation.

GPS and astronomers use the extended-time-span Julian Dating System, a sixteenth century innovation by a French classical scholar who named it after his father, Julius; it has no relation to the Julian Calendar. The Julian Period's start was arbitrarily fixed at noon, January 1, 4713 BCE, an instant coinciding with the beginning of two lunar cycles and one chronological cycle used in antiquity; re-commencement of all three cycles will not repeat for 7980 years. GPS Time Zero was established at midnight, UTC (Universal Time Coordinated, as maintained by the U.S. Naval Observatory), on Saturday, 6 January 1980 at the Greenwich meridian on Julian Day 2,444,244.5. The current Julian Day can be calculated by multiplying 365.25 and the number of intervening years, then adding the product to Time Zero.

With P-Code ranging, GPS switches via deductive algorithms from a "stopwatch" computation to a "tape measurement." Modulation on dissimilar frequencies causes the P1 & P2 signals to experience apparently unlike timing delays as they penetrate the ionosphere; these variations allow a receiver's firmware and/or postprocessing software to compare minutely differing times of signal arrival and deduce a true delay time. Other than clock error (timing offset), ionospheric signal disruption is the greatest contributor to SV ranging error. Unfortunately, the final year of this century and millennium, 2000, promises a cyclical increase in solar activity. The result: more vigorous ionosphere dynamics certain to have a deleterious effect on GPS reception worldwide.

When DoD actuates Anti-Spoofing, P-Code is encrypted into Y-Code and the string of 0s and 1s is transmitted at a significantly lower bit rate. The private sector employs various "Y-buster" techniques to mitigate or overcome P-Code signal corruption, among them a patented process that separately matches L1 and L2 Y-Code bit rates against locally generated (known) P-Code rates, then correlates them on each separate frequency to reveal the encrypting code's embedded bit rate. Signal integration in this manner permits an estimation of encrypting bit rates for each frequency; these are then fed to the opposite frequency. This effectively nulls the classified encrypting code and leaves pure carrier-frequency observables from which ranging data (full-wavelength carrier phase determination—the figurative "tape measurement") is obtained. Carrier phase refers to the fraction of a cycle, often expressed in degrees, with 360 degrees representing one full cycle; it can also mean a number of complete cycles (integers), plus a fractional cycle.

Despite this ingenious approach, "ambiguities" are introduced into phase measurements (the shortest "tape measure" increment is short indeed (L1 wavelength = 19 centimeters). Ambiguity is defined as the initial bias in a carrier-phase observation of an arbitrary

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number of whole cycles, or an uncertainty as to the number of whole cycles (integers) a receiver is trying to count. A GPS receiver can initially measure only the carrier's phase, not the number of whole cycles associated with that measurement. Valid ranging data leading to accurate position solutions are obtained via realtime differential corrections generated within a receiver's firmware algorithms, or within after-the-fact post-processing software.

Differential GPS (DGPS) Data Processing

As implemented by GPS, difference (the amount by which a quantity is larger or smaller than another) refers to the arithmetic "differencing" of carrier phases measured simultaneously by (1) a pair of receivers tracking the same SV (receivers-to-SV difference); or (2) by a single receiver tracking two SVs (SVs-to-receiver difference). Essentially (1) deletes all SV clock error, while (2) essentially deletes all receiver clock error. A double difference equals the arithmetic differencing of carrier phases measured simultanously by a pair of receivers tracking the same pair of SVs, which again removes SV and receiver clock error(s). A triple difference equals the arithmetic differencing of sequential, double-differenced carrier phase measurements that are now free of integer ambiguities, and therefore useful to determine initial, approximate site coordinates. Triple differencing is also used to detect cycle "slips" in carrier-phase data.

Acquiring either realtime or post-processed ranging data by the differential method requires two or more GPS receivers linked by some form of telecommunications, where a "base station" receiver posted at a known location (a survey monument or similarly established point) transmits differential corrections to one or more "rover" receivers either moved periodically along a "baseline" distance, or continuously in motion. DGPS differences the ensuing ranging changes through a series of short or long observation epochs spent by one or more "rover" receivers recording position data. The initial ambiguity (integer bias) is determined either concurrently through realtime data processing, or subsequently during post-processing in an office environment. In either case, ambiguities are successively computed and resolved.

Carrier Phase Differential (CPD) processing, a more recent technique, is capable of effectively obtaining realtime, centimeter-level, or better, 3D position solutions. From the moment more than four GPS observable SVs were orbited, an MIT team demonstrated the geodetic accuracies achievable by using integer-ambiguity-resolved, double-differenced carrier phase observables. A 1985 MIT paper described a dual-band experiment, where a 15 km baseline was measured to an accuracy of 15 mm using 15 minutes of data collection—a precursor of the modern technique known as "rapid static" survey.

Surveyors routinely measure baselines to accuracies, in all three dimensional components, of better than 1 part per million of total baseline length; under optimum conditions, geophysicists can measure global receiver networks to 3D positions of even greater accuracy. State-of-the-art GPS receivers, detecting sub-meter, pseudo-range observables and sub-centimeter carrier phase observables on both the L1 and L2 frequencies, have allowed the development of realtime ambiguity resolution, while sophisticated software permits the measurement of positions (relative to the fixed base station receiver) to one centimeter in realtime, and can do so "on the fly," while the "rover" receiver is in motion.

Unlike code-phase differencing, CPD doesn't compute passing range corrections, but differences actual carrier phase measurements, removing common, uncontrollable errors that can't be accurately measured otherwise (e.g.,

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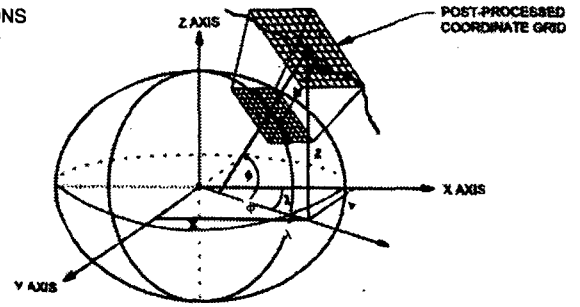
Figure 3 Earth-Centered Earth-Fixed Cartesian Coordinate System

POSITION CALCULATIONS
(SIMPLIFIED)

$X = (N+h)\cos\phi\ \cos\lambda$
$Y = (N+h)\cos\phi\ \sin\lambda$
$Z = [1-E^2)N+h]\sin\phi$

where: $N = a/\sqrt{(1-e^2\sin^2\phi)}$



Data postpocessing is usually required to reconcile GPS 3D position data to a latitude, longitude, orthmetric elevation, state plane coordinate, or similar grid.

clock offset error from not one but two timing sources, or apparent signal delay variations due to the constantly fluctuating ionosphere). Single, double and triple differencing are used to locate and cancel errors common to each progressive set of equations, hence phase ambiguity is gradually deleted from the equations because it is identified as common to the first reception within an observation epoch, the second, third and fourth, et cetera.

Satellite Navigation Message

GPS Master Control periodically uploads corrective information into each orbiting SV. The SVs transmit (at 50 bits/sec in 1,500-bit frames) yet another binary sequence embedded within the C/A Code that contains:

- Each individual SV's ephemeris & timing offset data (orbital trajectories & times of passage, plus clock correction parameters)
- Almanac data (predictive trajectories/times of passage for the entire SV constellation, plus currently anticipated clock offset parameters for all SVs)
- GPS constellation status (SV "health" information)
- Other esoteric data required by a receiver to compute position, velocity & time.

To repeat, lacking a receiver's active duplication (autocorrelation) of the C/A Code identity peculiar to each particular SV, the navigation message is not retrievable.

The GPS Coordinate System

Our planet is a rotating rather than a static inertial reference platform. All GPS timing indices and mathematical computations leading to position solutions are therefore based on a meld of the actual and theoretical. The Conventional Terrestrial System (CTS), based on the planet's Earth Centered Inertial (ECI) center of mass, is also the basis of the Earth Centered, Earth Fixed (ECEF) Cartesian Coordinate System. ECEF's Z-axis is aligned with the planet's mean spin axis (polar), its X-axis with the Greenwich meridian in the equatorial plane, and its Y-axis aligned orthogonally westward 90° to the X-axis, also in the equatorial plane (**Figure 3**).

Gravitational constants and anomalies measured worldwide via static or gyrostabilized airborne and/or orbital gravimetric sensors are used to construct a computer-simulated figure called a

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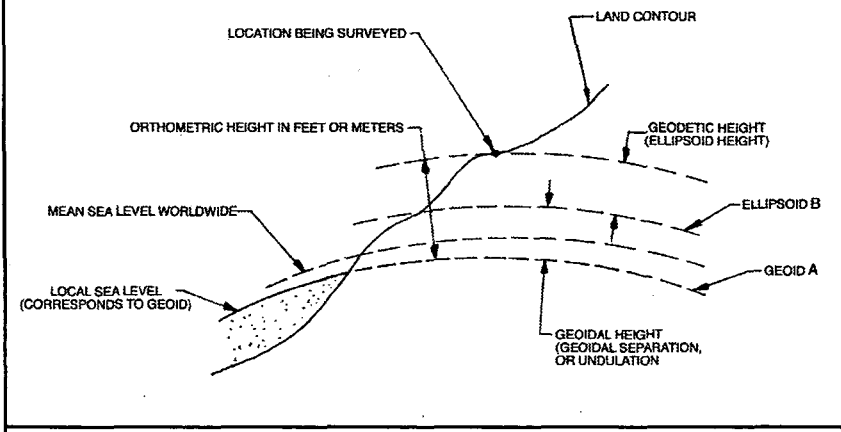
Figure 4 GPS Height Relationships



(A) Geoid: The physically defined "equipotential" surface of Earth's gravity field that best fits sea level, as if the oceans were extended through the continents.
(B) Ellipsoid of Revolution: A mathematical representation of the Earth's surface in the form of a three-dimensional ellipsoidal figure rotated about its minor axis (technically, the "equipotential" surface of a rotation homogenous body that approximates the geoid as closely as possible, but does not coincide with any of the planet's level surfaces).

geoid. This imaginary figure's surface is coincident with mean sea level as if the oceans extended through the continents—an "idealized body of water" centered at the ECI that figuratively covers the globe without wave action, tide or current (technically, a uniform surface whose hypothetical gravity gradient equals the equilibrium state of water at sea level).

Transforming GPS-derived X-Y-Z coordinates into curvilinear latitude, longitude, and elevation requires a second step: the definition of a purely mathematical (though physically-based) ellipsoid of rotation (in geophysical terminology, a rotationally equipotential surface). Not just any ellipsoid, however, but the geometric figure most closely matching the geoid's overall contour, its major and minor axes also coincident with the ECI. The smooth, mathematical ellipsoid model best conforming to the planet's actual shape is then superimposed on the gravimetrically derived geoid, and the variation in "geoid height" in any locale is termed geoidal undulation. Planetwide, the net variation between geoid and ellipsoid is effectively zero, though in specific areas it can vary as much as ± 100 meters.

Classic survey designates vertical "heights" as orthometric elevations above sea level—numerical values in feet or meters cited on countless maps and charts. Reconciling precise orthometric elevations and geoid heights, from which ellipsoid heights (vertical position solutions) are derived, remains problematic. Researchers are looking at ways of combining conventional survey leveling, GPS positioning data, and gravimetric data via integrated geodesy in an attempt to resolve this dichotomy (**Figure 4**).

Timing

Despite the all-but-perfect output of atomic clocks, the Doppler effect applies to the electromagnetic as well as the audio spectrum, resulting in relativistic time dilation (also known as second-order Doppler effect). An SV's mean

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orbital velocity, just under 4 km/sec, is an exceedingly small fraction of photon velocity. Yet time dilation does occur, causing atomic clock sine waves to be minutely shifted toward longer wavelengths—a redshift detectable by GPS receivers as an apparently "slowed" signal. Therefore hypothetical clocks, theoretically installed at the ECI, establish specific coordinate times, allowing GPS Master Control to apply sets of systems corrections to the atomic clocks distributed on-orbit: adjustments that compensate for time dilation due to SV velocity, for redshift due to SVs orbiting in a different gravitational realm, for clock bias due to the ionospheric Sagnac effect, Eötvös effect and others (a round dozen altogether). Some are so minute or esoteric that they either self-cancel, are written off as unavoidable systems error, or are left for private sector firmware/software developer reconciliation. Adjusted time, then, is transmitted as a hack precisely equivalent to time calculated as if generated by static, hypothetical clocks situated at the Earth-centered, Earth-fixed inertial reference point.

GPS Accuracies

Obtaining highly accurate GPS position solutions depends on numerous factors: valid clock offset corrections; the transmission quality/quantity of data from observable SVs; the respective height(s) of SVs above the horizon; the time spans dedicated to observation epochs; receiver quality; unpredictable ionospheric signal perturbation(s); the mathematical/operational integrity of associated processing algorithms; line-of-sight obstructions at a particular site; "multipath" signal scattering due to trees, urban and natural canyons, or other reflective/refractive surfaces; and of course user competence. A down-to-earth example of the multipath phenomenon occurs when an aircraft flies low overhead and scatters a television signal, causing the roof antenna to send multiple disrupted signals to the TV receiver.

Keeping these conditional attributes in mind, single-frequency receivers compiling only L1 pseudo-range data are capable of limited accuracies, especially with DoD Selective Availability "signal dithering" activated. Occupying the middle ground, two receivers collecting code-phase measurements, then subjecting them to either realtime or post-processed differential ranging corrections, can achieve (under optimum conditions) submeter accuracies. At the high end of the scale, a pair of advanced, radio-linked, full-wavelength, multi-channel receivers collecting dual frequency carrier phase measurements, plus modulated codes, can difference out common errors and achieve 3D millimeter-level accuracies, and can do so in realtime over relatively long baseline distances.

In sophisticated GPS applications like photogrammetry—a GPS-guided aircraft remote sensing technique that employs a high-resolution camera—used routinely as the basis for GIS and LIS mapping, or in realtime ship/aircraft navigation, where attaining precise "waypoint" ("where are we as of this instant?") solutions are imperative, accuracy is largely a function of progressive SVs-to-receiver(s) geometry, a factor less important to surveyors, where individual observation epochs of poor geometry can be averaged with periods of good and often superior geometry. Dilution of Precision (DOP) defines the geometric quality of observables by citing dimensionless numbers indicating the relative strength of a geometric figure formed by a GPS receiver and four or more SVs in line-of-sight. The smaller the DOP value, the stronger the figure's geometry.

Position Computation

All well and good, but how does a GPS receiver calculate where the satellites it "sees" are in respect to a ground point? And in light of the acquired information, how is it possible to calculate

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exact surface 3D coordinates? The answer is via applied trigonometry.

GPS receivers naturally require information in addition to ranging data. The Satellite Navigation Message, output at the rate of one bit every 20 repetitions of the C/A Code, "inverts" once each 20 milliseconds to mark a bit boundary that flip-flops the subsequent bit's value to either 0 or 1. Among the salient information described earlier, this message contains data that allows a receiver to simultaneously achieve realtime position fixes on all SVs in line-of-sight and above the receiver's selectable Elevation Mask (adjustable, artificial horizon cutoff). Utilizing this data, plus ranging multi-measurements to all observable SVs, a receiver's or postprocessing software's algorithms interpret the geometric figure thus formed and compute its configuration (usually at one-second intervals in realtime, or throughout seconds- or minutes-long observation epochs).

Software and Firmware

Single-frequency processing firmware/software algorithms typically initialize the phase measurement procedure with a triple difference, then work backward to a double difference in two stages: "float," and "fixed." Initial "floats" passing through the double-differencing equations are designed to solve for baseline ΔX, ΔY, and ΔZ components, but more importantly to detect and solve phase integer ambiguities, then resolve and delete them. What remains equals the whole number of cycles (integers) necessary to provide valid ranging data to all observable SVs. If the ambiguities are initially resolved to a point where integer values can be determined, they're "fixed" in the equations and additional double differences are run to solve only for ΔX, ΔY, and ΔZ. If ambiguities are resolved at this stage, the "fixed" solution is the best obtainable; if not, further processing or postprocessing becomes necessary.

Newer, innovative firmware and software programs differentially process carrier frequencies as well as modulated P-Code/Y-Code phase measurements. This is accomplished in realtime by using other techniques, such as P-Code phase solutions, to initialize the procedure. All data reduction programs use some form of differential processing, and most also double-difference at one stage or another. Without phase measurement differencing, position solutions can't help but include significant errors.

Innovation

Recently developed GPS+GLONASS technology introduced single-frequency (L1), 24-parallel-channel receiver systems able to seamlessly integrate U.S. GPS and Russian GLONASS (*Global'naya Navigatsionnaya Sputnikovaya Sistema*) signals. The domestic and foreign SV "constellations" each offer 24-hour, worldwide all-weather coverage, but with diversity. GLONASS SVs sustain lower, more stable orbits—8 staggered in 3 orbital planes, versus 4 in 6 orbital planes for GPS. Each GLONASS SV transmits its own unique frequency, orbits once each 11 hours rather than 12, and features a different code structure—variations that actually offer the collateral benefit of simplifying data synchronization. Observables from multiple SV systems also improve point positioning, code differential, carrier-phase differential, and post-processed data reduction; an added bonus is that GLONASS signals are not degraded for military purposes. This advanced technology obtains autonomous (non-differential) position/velocity results much more readily and accurately than is possible with stand-alone GPS receivers. In short, GPS+GLONASS is certain to lead to a host of new applications as well as heightened effectivity for existing ones, something especially true in urban and mountain canyons, regions harboring dense forest canopies, deep open-pit mines, and other locales where a multiplicity of observable satellites greatly fa-

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vors reception when a major portion of the sky is obscured.

Current & Future GPS Applications

A 1995 report from the director of Sweden's National Land Survey mentioned GPS measurements of ". . . postglacial rebound in Fennoscandia," the realtime monitoring (via a radio-linked network of permanently monumented GPS reference stations) of vertical and horizontal crustal reformation, a result of the land recovering from the tremendous weight of overlying ice 20,000 or more years ago. In the same year, an international academic and scientific consortium established a geodetic reference system, and geocentric datum, for the entire South American continent called SIRGAS (*Sistema de Referência Geocêntrico para a America do Sul*). The network employed hundreds of GPS receivers on the mainland, plus outliers at the northern tip of Antarctica, on the Galapagos Islands and *Isla de Pascua*. Formerly unforeseen applications such as continuous seismic monitoring, the continuous integrity monitoring of dams and other major structures, point up the fact that GPS technology has invaded, will continue to invade, and eventually pervade application territories as yet unplowed. The list grows daily; a prediction of where GPS technology will take us is meaningless.

At any rate, the next time someone utters the jocular quip, "You can't get there from here," energize your handheld GPS receiver and punch up the display (not the comedian). Then put him in his place (in more ways than one) by defining exactly where "here" is, precisely the distance and direction of "there" and—unless he gets lost—exactly when he's due to arrive. ■

A former California aerospace engineer, and occasional contributor to Analog, *William Walling now writes GPS application articles as a technical journalist with the world's leading satellite access technology corporation.*

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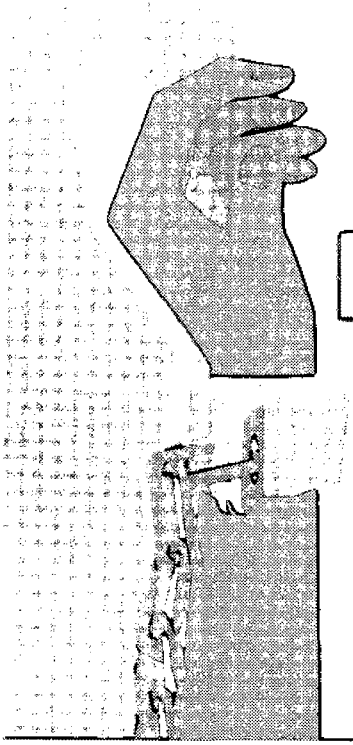

Laurence M. Janifer

THE POISONED FEATHER

Inventions can find applications quite different from what the inventor had in mind. . . .

I would have got around to him all by myself, sooner or later. I'd promised to do that, and I'd made the promise to myself. It is not a good idea to break a promise you make to yourself; it might just start you thinking that you're not trustworthy—which is harmful to your mental health, whatever it may be.

Roubor Transic, that unpleasant fellow, was definitely going to be a target marked For Destruction by Gerald Knave: Survivor—sooner or later. After all, the man had made his hobby into a very high-paying living, and his hobby was torture. Something, clearly, had to be done.

But before I got around to it on my own—well, I'd been busy—Marechal Field ran into me.

He'd planned to do that, and he'd left his home planet, and all the lovely surroundings to which Marechal Field and all his clan were accustomed, to find me on Bolitho, where I'd been clearing up a small matter for an old—almost a senile—friend. I'd been staying at a decent hotel in Barra, which is the planet's one and only capital city, and I was not hard to find: why should I have been? Marechal Field, fifty years old and an erect, soldierly figure of a man, with ice- blue eyes, large white mustachios and a shiny bald head, wasted no time at all in showing me the ransom note.

It was short, to the point and almost completely unhelpful.

Leave one million dollars in good metals in a locker in Gravesend Port. You will be watched. Do not set any guard on the locker, or attempt to oversee it in any way.

Whether or not you leave the ransom, your daughter Melissa will be returned to you. If you do leave the ransom, she will be returned alive, unharmed and in one piece.

Roubor Transic

Illustration by Shirley Chan

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"The torture business," I said reflectively, "must be a little slow these days."

Field grunted. "There's no time," he said.

"I see that," I said. Transic had written almost a generic ransom note: no specific locker named (well, Field would, it said, be watched), and no deadline set for payment. Only the name of the victim had been filled in. "When did you find out Melissa was missing?" I said. It didn't sound like a useful question, but you have to start somewhere.

Field ignored it. "I called him," he said. "I needed time to get the money—to turn it into metals—so I called him. He was—my God, Knave—he was very pleasant."

"He has a lot of ways of getting rid of his aggressions," I said. It wasn't a bad setup for a ransom demand: leaving the locker number open meant that Field had to be absolutely certain he was being watched when he dropped off the money; that got Transic better odds on clearing the area of unfriendlies than anything else I could think of. And the open date put Transic in phone contact with Field without Transic's having to initiate the call.

"I suppose he didn't say anything incriminating over the phone," I said.

"He discussed the delivery of something for payment," Field said. "I forget what. Oranges, I think. No, peaches. Oh God, he went on and on about how lovely this particular peach was."

That was Transic's style: whenever you can safely stick pins in a victim, do so.

"And you arranged a date," I said.

"I asked for ten days," he said. "Transic gave me a week. I—I made arrangements immediately—and then I—"

"You came to find me," I said. "Maybe Transic had you followed every minute after the original note had been delivered. And maybe not; no sure way to tell. Just by the way, how *was* the note delivered?"

"Ordinary mail," Field said. "From some postal office or other on the Reel."

Which was Transic's planet of residence. All very simple, all very neat—and as risk-free as a kidnap demand ever gets.

"My God, Knave," he said. "This is Roubor Transic. You've got to help me. Melissa—she's twenty-two, she's just a kid. My God, Knave. A week with Transic—"

"He won't harm her until day eight," I said. "He wants his ransom—and he might be thinking ahead, to making a demand on someone else, somewhere else. So he'd return the girl in good condition." I was nowhere near as sure of this as I hoped I sounded, but Field nodded and looked a little relieved.

"I suppose so," he said. "Kidnapping—and the police can't—"

"Once she's returned," I said, "she can complain to somebody. But it's not likely to do any good. Transic will have fifty witnesses to swear he was right here on Bolitho, or on Earth, or God knows where."

"But—"

"Transic tortures people," I said. "Lots of other people know about that, though he's been careful enough to avoid arrest—so far. And being on the Reel, that odd so-called pleasure planet where money makes most of the laws, helps a lot."

He said it again. "But—"

"A man who has a reputation for torturing people," I said gently, "can usually scratch up people who will swear to anything he wants them to swear to."

Field sighed. I was thinking fast, but I tried not to let it show. "I suppose so," he said. "Knave—"

"Will I help you?" I said. "If I agree, you're going to have to help me."

"Money isn't important," he said. "Melissa—my God, Knave, she's just a kid. In Transic's clutches. A week. Six days, now. Suppose—"

"She'll be fine," I said firmly. "And I wasn't talking about money. I'll need things from you. Supplies. This isn't going to be easy."

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"But you will—"

"I will," I said. And felt doubtful about it, right then and there.

Marechal Field was, as I may have implied, a very rich kind of fellow. He's the Field of Field's Fields (try saying those six words five times fast without feeling like a damn fool), a company that might as well be alone in its area of expertise, small-field work. Large fields—shielding for a building or a person or a ship, say—are common enough, but small fields are a little special: they're the kind of thing that is perfectly possible in theory and only just barely possible in actual fact, for sixty or seventy perfectly good, and very lengthily technical, reasons.

Field had found a trick or two for the manufacture of fields covering individual objects—your priceless heirloom vase, for instance, or one particular bit of your lab equipment—or, in fact, anything. He was working, he told me (I talked with him for quite a while that day, feeling that, once I'd agreed to help, the flow of conversation would keep him calmed down—and after all, we had to do *something* while he was on and off the phone ordering wooden crates and the latest in human-sized shields and so on)—he was working, at any rate, on a fascinating notion: fields small enough to be used as lubricating tools.

"We can wrap individual ball bearings, for instance," he said. "The field can be beamed from a distance—about a quarter-mile is the beam limit—and the generating equipment weighs less than most lubricants, for complex jobs. Beaming equipment miniaturized, of course."

"But it's got to be more expensive than lubricants," I said.

"Yes and no," he said. "Power costs are minor. And you never have to buy a refill, so to speak—the generator, suitably instructed, has a good lifetime. Specify your field, specify location and shape and strength, specify thickness—just name it—and the generator's good for fifty years before maintenance check, minimum. It costs more than a can of lubricant—but you never have to buy a second can."

"Even so—" I said.

"The first sales are going to be to people rich enough to want the novelty, and boast about it," he said. "People who want it for their cars or planes—the generator's really lightweight—or for some household device like a Robbie, or any mech."

"And rich enough so they won't mind the price," I said.

"We think there are enough people like that to make quantity production feasible," he said. "And that lowers cost—which means price will go down, in a couple of years, and we can *really* start selling the thing."

It sounded as if Marechal Field was going to have a brand-new fortune to pile on top of his old one. A million dollars in ransom was a drop in the bucket.

But Melissa Field wasn't, in fact, all that safe in Roubor Transic's hands. And I had said I'd help out.

And there was that promise I'd made to myself, too.

But, as I'd also said, it wasn't going to be easy.

The first step was the delivery, as from a third party who had no known connection either to me or to Field, of a crate of chains and manacles—a big, expensive wooden crate, full of perfectly good, even showy equipment—to Transic.

The second was a flat-out, open assault on Roubor Transic's combination home, office and torture dungeon—his large manor house on the outskirts of one of the cities on the Reel. A brave, thorough assault by Gerald Knave.

It failed, of course. I was shielded, but there are ways to get through any shield, and Transic, as any sensible person might have figured, knew six or eight of

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them. There was one risk: it was always possible that Transic would decide on the simple answer, and kill his assailant out of hand.

In that case, of course, all my worries would be over, so I didn't waste time wondering about the odds. And, when you did think about it, the odds were in favor of the more complicated answer: Transic, after all, not only tortured people for hire—to extract information or to persuade them to do whatever it was the client wanted done—but as a hobby, for its own sake. He liked it.

Torturing Gerald Knave seemed like his most likely aim—if, of course, he could capture Gerald Knave.

I made my valiant assault, and the assault made my capture possible. It wasn't an hour after the assault—my best guess; when Transic got through my shield, unconsciousness was bare seconds away—that I woke up. My surroundings were not a surprise, but they were certainly a shock, to every available sense.

I have not seen many torture chambers; few of us have, except on 3V horror shows, where they're sanitized. But this was the real thing.

Transic was a traditionalist: the walls were stone, in large rough blocks, and the floor was stone too, with little gutters here and there to carry away whatever liquids were released when the place was in use. Lighting was electric, and not too dim—tradition is fine, but smoky torches are a damn nuisance to deal with, and half the time you can't see what you're doing—and quite sufficient to show me a perfectly serviceable rack, a metal container on wheels filled with what I suspected were branding irons, an open closet full of whips and manacles, a knife or two lying around on the leather-covered benches—well, I won't do the whole list now, but none of it created feelings of delight in my bosom.

The place echoed, and it smelled. Neither was a comforting fact, somehow. My mouth held a vaguely metallic taste I recognized as a very deep and basic fear.

And I was entirely naked. My clothing was lying, neatly folded, on one of the benches, looking unharmed but somehow forlorn. I was chained and manacled to one of the uncomfortably rough stone walls, with a depressingly good view of the rest of the torture chamber.

There is an ancient cartoon, apparently very popular away back before the Clean Slate War. In a way, it expresses the ancients' whole attitude as regards war and many other unpleasantnesses. It shows two men, both of them spread-eagled on just such a stone wall, hands and feet manacled, fixed immovably. One of them is saying: "Now, here's my plan . . ."

I was fixed exactly like the fellows in that cartoon, except that I had no company; the chamber was empty.

Now, I thought to myself, pulling against the chains and manacles and discovering that they had no more give to them than I expected them to have—here's my plan . . .

At that moment the door opened—with a faint creak he must have had specially built—and Transic came in. He shut the door carefully behind him, leaned against it, and looked across to me, on the right-hand wall. He smiled.

"Greetings, Knave," he said. "It's quite a feather in my cap, getting you here. I won't say I hope you enjoy your stay, but I'll say that I certainly will—and that it will be a much longer stay than you'd like it to be." His smile broadened; he was actually beaming at me fondly. I was a feather in his cap, and he was going to be handling the feather very roughly.

It was not a pleasant sight, that beam of his, any more than his speech had been a pleasant speech. His voice, for one thing, was a choked sort of tenor gurgle, of great volume but little precision; he sounded as if he were always talking around an immense wad of something moist and sticky he could neither swallow nor spit out.

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And his looks gave me a notion of why he'd taken up torture as a hobby. He was short and lumpy—not round, exactly, but full of unexpected swellings and concavities here and there. He looked deformed, without my being able to pinpoint any individual, particular deformity: he looked, to put it very briefly, as if he were hunchbacked all over.

He was not bald; baldness would have been an improvement. Hair stuck out on his head, on his elbows, on what I could see of his chest (he was wearing an open-shirted jumper, in traditional black), in discouraged little clumps. It looked like a pale-brown kind of weed growth.

His eyes were a pale blue.

All in all, I could read his history in his looks, or I thought I could. If he'd looked anything like that during his formative years, every human he'd come in contact with had either laughed at him or run screaming away. He'd taken up torture as revenge on a race of beings who'd treated him so badly.

They do say that to understand all is to forgive all. This doesn't seem to be so. I understood what had made Transic what he was—or I harbored a reasonable guess at the notion—and the picture I had did not fill me with forgiveness. There was a little sadness for the unhappy childhood, but there was also the knowledge that there are, for six thousand reasons, a lot of unhappy childhoods—and comparatively few hobbyist torturers.

Well, there we were, and there was nothing to do but play the scene out. "You're going to regret this," I said, and he beamed at me again.

"I know I am," he said. "I'm going to regret its brevity. I'd like to keep you here for—oh, say a couple of years. I understand you're very fit and healthy—but I'm afraid we won't be able to manage more than—" he reflected, grinning "—oh, say a week or so." He took a couple of steps toward me. I didn't move—Hell, I was as fixed there as if I'd been sprayed to the wall. "Of course," he said, beaming, "it will seem much longer."

I said: "It won't be a week. In fact, it won't be an hour."

"Bravado," he said. "Very good, Knave. Very good, We'll have to see how long the attitude lasts." Then he stopped, apparently to think. "You're here because of Melissa Field, aren't you?" he said.

"Why should I tell you anything?" I said.

He shook a finger at me. "Now, now," he said. "In time—in a very short time, though it won't seem short to you—you'll be ever so anxious to tell me all sorts of things."

"I doubt it," I said.

"Believe me," he said. "But what's the harm in your telling me that?"

None, of course. But I felt reluctant to do anything that Transic asked me to do. A very unpleasant fellow.

"I happened to be on-planet," I said, "and I thought I'd drop in. Just by the way, where is Melissa Field? I suppose you had her father followed when he left to see me."

"Melissa is quite safe," he said, and the grin lessened by fifty percent. "A shame, really. I have been thinking—once I collect the money, why go to all the bother of actually returning the girl? She'd while away an interesting few days, I'm sure—and I do hate to be at loose ends. Would you believe it, Knave? When I dispose of you, there won't be a soul here except for me and the Field girl."

As I'd thought, the torture business had hit a slow patch. "No servants?"

"All mechanical," he said, with a faint tinge of regret. "They dragged you in and chained you up, of course; I do very little of the heavy work myself." A little bow, God knows why. "You have no idea how hard it is to find good servants—servants who will respect your hobbies."

"I think I can guess," I said. "But about Melissa Field—"

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"In a few minutes I'll call them, and we'll begin. Why be tiresome?" he said, and shrugged. "She's safe, and she's somewhere about the place; what more do you need to know? She can't rescue you. In fact, nothing and no one can rescue you."

"You're sure of that," I said.

"No one else is within a mile of my house," he said. "Telltales inside would have told me if anyone except you had entered it."

"So we're alone," I said. He bowed again.

"Quite."

"And if anyone came within a mile of this place—"

"I would know at once," he said. "I did get an unexpected delivery yesterday—a lovely crate full of equipment."

Field's wooden crate, of course. I held my breath.

"Rather a transparent ruse, though," he said. "I did examine the nice chains and the manacles, and saw nothing wrong with them—" No surprise to me, as there hadn't *been* anything wrong with them—"but I'm sure they were gimmicked in some odd way or other." He smiled. "If I'd been such a fool as to use them on one of my subjects—on you, for instance— I'm sure they'd have broken, or dissolved, or somehow or other let you free yourself."

"Maybe they would," I said, and tugged at my chains. Nothing moved.

"So I didn't use them," he said. "A very nice crate, though—I had my mechs put the whole thing in the basement—unopened and unused. Knave, I'd thought better of you—it was much too transparent a ruse."

"Really?" I said, and slipped out of the manacles, and landed on my feet, a foot or so in front of the stone wall.

Transic was staring at me as if I'd grown a second head. I gave him very little opportunity to think things over; I got over to him in three quick strides, and hit him once, square on the button. He went down in an untidy heap, and he was a Hell of a job to drag to the wall and fasten to the manacles.

There was, of course, nothing wrong with the manacles. Or the chains. Transic found that out when he woke up himself, a good deal less than an hour later.

I had one problem, but I didn't expect it to be serious, and it wasn't. God knew how his mechs were keyed for defense, if they noticed some stranger poking around the various chambers; I needed to get in and out fast, and Transic was going to help me.

I'd dressed while waiting for the lumpy little wart to wake up, and when he did I started questioning him. I never had to use the whip I was holding; I only had to finger it casually and look thoughtful. Torturers do not take well to even the threat of being tortured; they feel they belong on only one side of that particular equation.

The questioning period lasted about four minutes, and wouldn't have lasted that long if Transic hadn't been so insistent about finding out how I'd slipped out of the manacles on my wrists and ankles. "They're built to close tightly," he said, almost plaintively. "I've used them so many times . . ."

It wouldn't have taken that long, either, if I hadn't wanted the instruction codes for his mechs. He really didn't want to give those up, but the sight of that whip was too much for him; he knew what it could do. And the manacles were just as good as he kept telling me they were.

When I had what I needed, I left. I've never been back, and I don't plan to be; I was off-planet in an hour, and back on Bolitho, accompanied by a somewhat dazed but, thank God, wholly unhurt Melissa Field.

I never did tell Transic how I'd managed things. I didn't tell his mechs, either; I simply reinstructed them.

He'll stay there, spread-eagled to his rough stone wall, for a time we might label as "Indefinite." The mechs will feed

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him, keep him clean and reasonably healthy, and keep up the house itself. But I reprogrammed the recognition codes, and they won't treat him as Roubor Transic, nor will they obey any order he gives them. He's Mr. X to the mechs, a casual human to be taken care of just as well as possible, but never, never released.

I never told him a thing. But I'll tell you—not that I have to, I should think.

Marechal Field had buried a tiny transmitter in the wood of those nice crates. It had a quarter-mile range, and though Transic's house was big; it wasn't that big. The transmitter beamed small fields around my wrists and ankles.

That's all. The fields were thick enough to make the manacles a very loose fit, easy as Hell to slip out of; I had to stay there by holding the things with my hands until I was ready to get out.

And Field has gone even further. Every bit of my ship that called for lubrication, once upon a time, is now enfielded, and I own what may be the showiest ship anywhere.

If people ask how I got it, I have a variety of tales to tell them. I have a few tales about Roubor Transic, too—when I hear somebody wonder why he hasn't been heard from lately.

They all have him going on a long, long trip somewhere.

Why disturb the fellow?■

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Sarah Zettel

KINDS OF STRANGERS

Any explorer knows there are big dangers Out There—but some of the worst are "In Here."

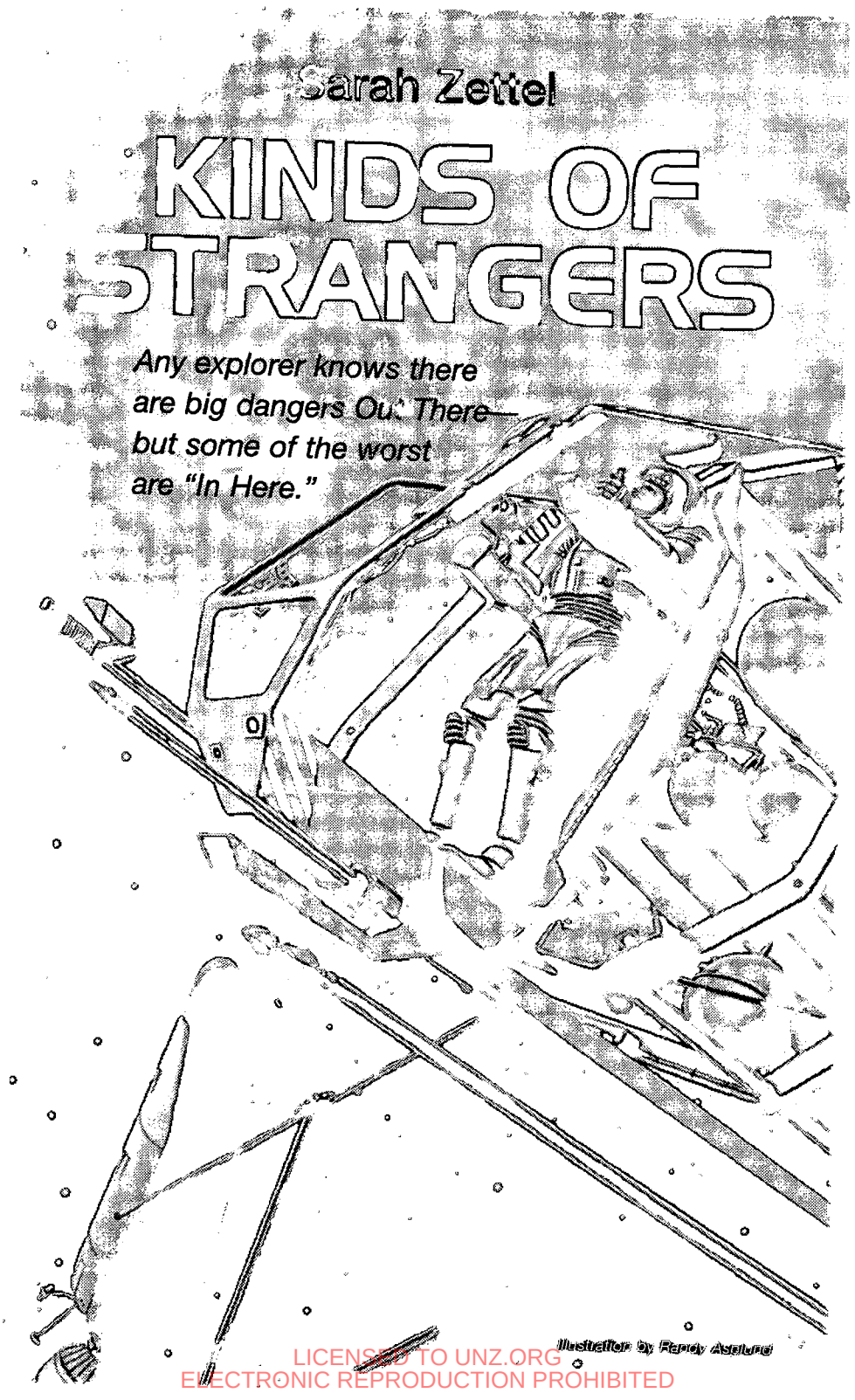

Illustration by Randy Asplund

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Margot Rusch pulled open the hatch that led to the *Forty-Niner*'s sick bay. "Paul?" she asked around the tightness building in her throat. She pulled herself into the sterile, white module. She focused slowly on the center of the bay, not wanting to believe what she saw.

Paul's body, wide-eyed, pale-skinned, limp and lifeless floated in mid-air. A syringe hovered near his hand, pointing its needle toward the corpse as if making an accusation.

"Oh, Christ." Margot fumbled for a handhold.

The ventilation fans whirred to life. Their faint draft pushed against the corpse, sending it toward the far wall of the module. Margot caught the acrid scent of death's final indignities. Hard-won control shredded inside her, but there was nowhere to turn, no one to blame. There was only herself, the corpse and the flat, blank screen of the artificial intelligence interface.

"Damn it, Reggie, why didn't you do something!" she demanded, fully aware it was irrational to holler at the AI, but unable to help it.

"I did not know what to do," said Reggie softly from its terminal. "There are no case scenarios for this."

"No, there aren't," agreed Margot, wearily. "No, there sure as hell aren't."

The crew of the *Forty-Niner* had known for three months they were going to die. The seven of them were NASA's pride, returning from the first crewed expedition to the asteroid belt. They had opened a new frontier for humanity, on schedule and under budget. Two and a half years of their four-year mission were a raving success, and now they were headed home.

There had been a few problems, a few red lights. Grit from the asteroid belt had wormed its way into the works on the comm antenna and the radio telescope. No problem. Ed MacEvoy and Jean Kramer replaced the damaged parts in no time. This was a NASA project. They had backups and to spare. Even if the reaction control module, which was traditional methane/oxygen rockets used for course corrections, somehow failed completely, all that would mean was cutting the project a little short. The long-distance flight was handled by the magnetic sail; a gigantic loop of high-temperature superconducting ceramic cable with a continuous stream of charged particles running through it. No matter what else happened, that would get them home.

"Margot?" Jean's voice came down the connector tube. "You OK?"

Margot tightened her grip on the handle and looked at the corpse as it turned lazily in the center of the bay. *No, I am not OK.*

The mag sail, however, had found a new way to fail. A combination of radiation and thermal insulation degradation raised the temperature *too* high and robbed hundreds of kilometers of ceramic cable of its superconductivity.

Once the mag sail had gone, the ship kept moving. Of course it kept moving. But it moved in a slow elliptical orbit going nowhere near its scheduled rendezvous with Earth. They could burn every atom of propellant they carried for the RCM and for the explorer boats, and they'd still be too far away for any of the Mars shuttles to reach by a factor of five. Frantic comm bursts to Houston brought no solutions. The *Forty-Niner* was stranded.

"Margot?" Jean again, calling down the connector.

"I'll be right up," Margot hoped Jean wouldn't hear how strangled her voice was.

Margot looked at the empty syringe suspended in mid-air. *Drunk all and left no friendly drop to help me after.* She swallowed hard. *Stop it, Margot. Do not even start going there.*

"Is there another request?" asked Reggie.

Margot bit her lip. "No. No more requests."

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Margot pushed herself into the connector and dragged the hatch shut. She had the vague notion she should have done something for the body—closed its eyes or wrapped a sheet around it, or something, but she couldn't make herself turn around.

Margot's eyes burned. She'd flown four other missions with Paul. She'd sat up all night with him drinking espresso and swapping stories while the bigwigs debated the final crew roster for the *Forty-Niner*. They'd spent long hours on the flight out arguing politics and playing old jazz recordings. She'd thought she knew him, thought he would hang on with the rest of them.

Then again, she'd thought same of Ed and Tracy.

Tracy Costa, their chief mineralogist, had been the first to go. They hadn't known a thing about it, until Nick had caught a glimpse of the frozen corpse outside one of the port windows. Then, Ed had suffocated himself, even after he'd sworn to Jean he'd never leave her alone in this mess. Now, Paul.

Margot pulled herself from handhold to handhold up the tubular connector, past its cabinets and access panels. One small, triangular window looked out onto the vacuum, the infinitely patient darkness that waited for the rest of them to give up.

Stop it, Margot. She tore her gaze away from the window and concentrated on pulling herself forward.

The *Forty-Niner*'s command module was a combination of ship's bridge, comm center and central observatory. Right now, it held all of the remaining crew members. Their mission commander, Nicholas Deale, sandy-haired, dusky-skinned and dark-eyed, sat at one of Reggie's compact terminals, brooding over what he saw on the flat screen. Tom Merritt, who had gone from a florid, pink man to a paper-white ghost during the last couple of weeks, tapped at the controls for the radio telescope. He was an astronomer and the mission communications specialist. He was the one who made sure they all got their messages from home. The last living crew member was Jean. A few wisps of hair had come loose from her tight brown braid and they floated around her head, making her look even more worried and vulnerable. She stood at another terminal, typing in a perfunctory and distracted cadence.

Margot paused in the threshold, trying to marshal her thoughts and nerves. Nick glanced up at her. Margot opened her mouth, but her throat clamped tight around her words. Tom and Jean both turned to look at her. The remaining blood drained out of Tom's face.

"Paul?" he whispered.

Margot coughed. "Looks like he overdosed himself."

Jean turned her head away, but not before Margot saw the struggle against tears fill her face. Both Nick's hands clenched into fists. Tom just looked at Nick with tired eyes and said, "Well, now what?"

Nick sighed. "OK, OK." He ran both hands through his hair. "I'll go take care of . . . the body. Tom, can you put a burst through to mission control? They'll want to notify his family quietly. I'll come up with the letter . . ."

This was pure Nick. Give everybody something to do, but oversee it all. When they'd reeled in the sail, he hadn't slept for two days helping Ed and Jean go over the cable an inch at a time, trying to find out if any sections were salvageable from which they could jury-rig a kind of stormsail. When that had proven hopeless, he'd still kept everybody as busy as possible. He milked every drop of encouraging news he could out of mission control. Plans were in the works. The whole world was praying for them. Comm bursts came in regularly from friends and family. A rescue attempt would be made. A way home would be found. All they had to do was hang on.

"In the meantime. . ." Nick went on

"In the meantime we wait for the radi-

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ation to eat our insides out," said Tom bitterly. "It's hopeless, Nick. We are all *dead*."

Nick shifted uneasily, crunching Velcro underfoot. "I'm still breathing and I don't plan to stop anytime soon."

A spasm of pure anger crossed Tom's features. "And what are you going to breathe when the scrubbers give out? Huh? What are you going to do when the water's gone? How about when the tumors start up?"

Tom, don't do this, thought Margot, but the words died in her throat, inadequate against the sudden red rage she saw in him. He was afraid of illness, of weakness. Well, weren't they all?

Paul's chief duty was keeping them all from getting cancer. One of the main hazards of lengthy space flight had always been long-term exposure to hard radiation. The mag sail, when it was functional, had created a shield from charged particles, which slowed the process down. Medical advancements had arisen to cover the damage that could be done by fast neutrons and gamma rays. Paul Luck maintained cultures of regenerative stem cells taken from each member of the crew. Every week, he measured pre-cancer indicators in key areas of the body. If the indicators were too high, he tracked down the "hot spots" and administered doses of the healthy cultured cells to remind bone, organ and skin how they were supposed to act and *voilà!* Healthy, cancer-free individual.

The Luck system was now, however, permanently down, and the only back-up for that was the AI's medical expert system and the remaining crew's emergency training. Right now, that didn't seem like anything close to enough.

"We have time," Nick said evenly. "We do not have to give up. Come on, Tom. What would Carol say if she heard this?" Nick, Margot remembered, had been at Tom's wedding. They were friends, or at least, they had been friends.

"She'd say whatever the NASA shrinks told her to," snapped Tom. "And in the meantime," he drawled the word, "I get to watch her aging ten years for every day we're hanging up here. How much longer to I have to do this to her? How much longer are you going to make your family suffer?"

For the first time, Nick's composure cracked. His face tightened into a mask of pent-up rage and frustration, but his voice stayed level. "My family is going to know I died trying."

Tom looked smug. "At least you admit we're going to die."

"No..." began Jean.

"Help," said a strange, soft voice.

The crew all turned. The voice came from the AI terminal. It was Reggie.

"Incoming signal. No origination. Can't filter. Incoherent system flaw. Error three-six-five..."

A grind and clank reverberated through the hull. Reggie's voice cut off.

"Systems check!" barked Nick.

Margot kicked off the wall and flew to navigation control, her station. "I got garbage," said Tom from beside her. "Machine language, error babble. Reggie's gone nuts."

Margot shoved her velcro-bottomed boots into place and typed madly at her keyboard, bringing up the diagnostics. "All good here," she reported. She turned her head and looked out the main window, searching for the stars and the slightly steadier dots that were the planets. "Confirmed. Positioning systems up and running."

"Engineering looks OK," said Jean. "I'll go check the generators and report back." Nick gave her a sharp nod. She pulled herself free of her station and launched herself down the connector.

"You getting anything coherent?" Nick pushed himself over to hover behind Tom's shoulder.

"Nothing." From her station, Margot could just make out the streams of random symbols flashing past on Tom's terminal.

"Reggie, what's happening?" she whispered.

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"I don't know," said the voice from her terminal. Margot jerked. "Unable to access exterior communications system. Multiple errors on internal nodes. Code corruption. Error. three-four. . ." the computer voice cut out again in a pulse of static, then another, then silence, followed by another quick static burst.

"Margot, can you see the comm antenna?" asked Tom, his hands still flashing across the keyboard.

Margot pressed her cheek against the cool window, craned her neck and squinted, trying to see along the *Forty-Niner*'s hull. "Barely, yeah."

"Can you make out its orientation?"

Margot squinted again. "Looks about ten degrees off-axis."

"It's moved," said Tom between static bursts. "That was the noise."

"All OK down in the power plant," Jean pulled herself back through the hatch and attached herself to her station. "Well, at least there's nothing new wrong . . ." she let the sentence trail off. "What is that?"

Margot and the others automatically paused to listen. Margot heard nothing but the steady hum of the ship and the bursts of static from Reggie. Quick pulses, one, one, two, one, two, one, one, one, two.

"A pattern?" said Nick.

"Mechanical failure," said Tom. "Has to be. Reggie just crashed."

One, one, two, one.

"You ever hear about anything crashing like this?" asked Margot.

One, two, one.

"Reggie? Level one diagnostic, report," said Nick.

One, one, two.

"Maybe we can get a coherent diagnostic out of one of the other expert systems," Margot suggested. Reggie wasn't a single processor. It was a web-work of six interconnected expert systems, each with their own area of concentration, just like the members of the crew. Terminals in different modules of the ship gave default access to differing expert systems.

"Maybe," said Nick. "Tom can try to track down the fault from here. You and Jean see if you can get an answer out of si . . . the power plant." Margot was quietly grateful he remembered what else was in sick bay before she had to remind him.

One, one, one.

Jean and Margot pulled themselves down the connector to the engineering compartment. As Jean had reported, all the indicators that had remained functional after they'd lost the sail reported green and go.

"At least it's a different crisis," Jean muttered as she brought up Reggie's terminal, the one she and Ed had spent hours behind when the mag sail went out.

"Remind me to tell you about my grandmother's stint on the old Mir sometime," said Margot. "Now there was an adventure."

Jean actually smiled and Margot felt a wash of gratitude. Someone in here was still who she thought they were.

Jean spoke to the terminal. "Reggie, we've got a massive fault in the exterior communications system. Can you analyze from this system?" As she spoke, Margot hit the intercom button on the wall to carry the answer to the command center.

"Massive disruption and multiple error processing," said Reggie, sounding even more mechanical than usual. "I will attempt to establish interface."

"Nick, you hear that?" Margot said to the intercom grill. She could just hear the static pulses coming from the command center as whispering echoes against the walls of the connector.

"Roger," came back Nick's voice.

"I am . . . getting reports of an external signal," said Reggie. "It is . . . there is . . . internal fault, internal fault, internal fault."

Jean shut the terminal's voice down. "What the hell?" she demanded of Margot. Margot just shook her head.

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"External signal? How is that possible? This can't be a comm burst from Houston."

Margot's gaze drifted to the black triangle of the window. The echoes whispered in ones and twos.

"What's a language with only two components?" Margot asked.

Jean stared at her. "Binary."

"What do we, in essence, transmit from here when we do our comm bursts? What might somebody who didn't know any better try to send back to us?"

Jean's face went nearly as white as Tom's. "Margot, you're crazy."

Margot didn't bother to reply. She just pushed herself back up the connector to the bridge.

"Tom? Did you hear that?"

Tom didn't look up. He had a clip board and pen in his hands. As the static bursts rang out, he scribbled down a 1 for each single burst and a 0 for each pair. He hung the board in mid-air, as if not caring where it went and his hands flew across the keyboard. "Oh yeah, I heard it."

Nick was back at his station, typing at his own keyboard. "The engineering exsystems seem to be intact. Maybe we can get an analysis . . ." He hit a new series of keys. Around them, the static bursts continued. Margot's temples started to throb in time with the insistent pulses.

"There's something," Tom murmured to the terminal. His voice was tight, and there was an undercurrent in it Margot couldn't identify. "It'll take awhile to find out exactly what's happened. I've got Reggie recording," he looked straight at Nick. "As long as it doesn't crash all the way . . ."

Margot and Jean also turned to Nick. Margot thought she saw relief shining behind his eyes. *At least now he won't have to find us make-work to do.*

"All right," said Nick. "Tom, you keep working on the analysis of this . . . whatever it is. Jean, we need you to do a breakdown on Reggie. What's clean and what's contaminated?" he turned his dark, relieved eyes to Margot. "I'll take care of Paul. Margot . . ."

"I'll make sure all the peripherals are at the ready," said Margot. "We don't know what's happening next."

Nick nodded. Margot extracted herself from her station and followed Nick down the connector. She tried not to look as he worked the wheel on the sick bay hatch. She just let herself float past and made her way down to the cargo bay.

The cargo bay was actually a combination cargo hold and staging area. Here was where they stored the carefully locked-down canisters holding the ore samples. But here was also where they suited up for all their extra-vehicular activities. Just outside the airlock, the explorer boats waited, clamped tightly to the hull. They were small, light ships that looked like ungainly box kites stripped of their fabric. The explorers were barely more than frames with straps to hang sample containers, or sample gatherers, or astronauts from. They'd been designed for asteroid rendezvous and landing. Margot remembered the sensation of childlike glee when she got to take them in. She loved her work, her mission, her life, but that had been sheer fun.

For a brief moment there, they thought they might be able to use the explorers to tow the *Forty-Niner* into an orbit that would allow one of the Martian stations to mount a rescue, but Reggie's models had showed it to be impossible. The delta-vee just wasn't there. So the explorers sat out there, and she sat in here, along with the core samplers, the drillers, the explosive charges, doing nothing much but waiting to find out what happened next.

Hang on, Margot. Stay alive one minute longer, and one minute after that. That's the game now isn't it? Forget how to play and you'll be following Paul, Ed and Tracy.

She touched the intercom button so

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she could hear the static bursts and Tom's soft murmuring. It reminded her that something really was happening. A little warmth crept into her heart. A little light stirred in her mind. It was something, Tom had said so. It might just be help. Any kind of help.

Small tasks had kept her busy during the two weeks since they lost the sail, and small tasks kept her busy now. She made sure the seals on the ore carriers maintained their integrity. She ran computer checks on the explorers and made sure the fuel cells on the rovers were all at full capacity, that their tanks were charged and the seals were tight. Given the state Reggie was in, she was tempted to put on one of the bright yellow hardsuits and go out to do a manual check. She squashed the idea. She might be needed for something in here.

She counted all the air bottles for the suits and checked their pressure. You never knew. With Reggie acting up, they might have to do an EVA to point the antenna back toward Earth. If this last, strange hope proved to be false, she still hadn't said good-bye to her fiancé Jordan, and she wanted to. She didn't want to just leave him in silence.

Reggie's voice, coming from the intercom, startled her out of her thoughts. "Help," said Reggie. "Me. Help. Me. We. Thee. Help."

Margot flew up the connector. She was the last to reach the command module. She hung in the threshold, listening to Reggie blurt out words one at a time.

"There. Is. Help." said Reggie, clipped and harsh. The words picked up pace. "There is help. Comet. Pull. Tow. Yourself. There is a comet approaching within reach. You can tow yourself toward your worlds using this comet. It is possible. There is help."

Margot felt her jaw drop open.

Tom looked down at his clipboard. "What Reggie says, what we've got here is a binary transmission from an unknown source. Taking the single pulses as ones and the double pulses as zeroes gave us gibberish, but taking the single pulses as zero and the double pulses as one gave us some version of machine language. The engineering expert subsystem was able to decode it."

He gripped his pen tightly, obviously resisting the urge to throw it in frustration. "This is impossible, this can't be happening."

Margot shrugged. "Well, it is."

"It can't be," growled Tom. "Aliens who can create a machine language Reggie can read inside of four hours? It couldn't happen."

"Unless they've been listening in on us for awhile," Jean pointed out.

Tom tapped the pen against the clipboard. One, two, one. "But how . . ."

Margot cut him off. She didn't want to hear it anymore. This was help, this was the possibility of life. Why was he trying to screw it up? "We've been beaming all kinds of junk out into space for over a hundred years. Maybe they've been listening that long." She felt his doubt his dribbling into the corners of her mind. She shut it out by sheer force of will.

Jean folded her arms tightly across her torso. "At this point, I wouldn't care if it was demons from the seventh circle of Hell, just so long as it's out here."

"Jesus," breathed Nick softly. Then, in a more normal voice he said, "OK, Margot, you and Jean are going to have to do an EVA to turn the antenna around so we can send a burst to Houston."

"We can't tell Houston about this," said Jean sharply.

"What?" demanded Tom.

Jean hugged herself even tighter. "They'd think we'd all gone crazy up here."

"What's it matter what they think?" Nick spread his hands. "It's not like they can do anything about it."

"They can tell our families we've all taken the mental crash," said Jean flatly. "I, for one, do not want to make this any worse on my parents."

Nick nodded slowly. "OK," he said. "We

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keep this our little secret. But if we do make it back, mission control is going to have a cow."

Tom looked from Nick to Jean and Margot saw something hard and strange behind his eyes. He faced Margot. "This thing with the comet, could we really do something like this?"

Margot's mouth opened and closed. A short-period comet, swinging around the sun. If they caught it on its way back in . . . if they could attach a line (hundreds of kilometers of unused cable coiled on its drum against the hull of the ship) . . . theoretically, theoretically, it could pull them into a tighter orbit. The stresses would be incredible. Several *g*s worth. Would they be too much? How to make the attachment? Couldn't land on a comet, even if the explorers had the delta-vee. Comets were surrounded by dust and debris, they ejected gas jets, ice and rock. Asteroids were one thing. Asteroids were driftwood bobbing along through the void. Comets were alive and kicking.

But maybe . . . maybe . . .

"We'd need to find the thing," she said finally. "We'd need course, distance, speed. We'd need to know if we can use the RCM to push us near enough to take a shot at it. We'd probably need the explorers to do the actual work of attaching the *Forty-Niner* to the comet . . ."

"We could use the mag sail," said Jean. She gnawed slowly on her thumbnail. "All that cable, we could use it as a tow rope. But we'd need a harpoon, or something . . ."

"A harpoon?" said Tom incredulously.

Jean just nodded. "To attach the tether to the comet. Maybe we could use some of the explosives. . ."

Nick smiled, just a little. For the first time in days, Margot saw the muscles of his face relax. "Jean, let's get down to engineering and see what we can work up. Tom, you and Margot find our comet." His smile broadened. "And keep an ear out in case the neighbors have more to say."

"No problem," said Margot. She raised her arm and whistled. "Taxi!"

Jean, an old New Yorker, actually laughed at that, and Margot grinned at her. Nick and Jean pulled themselves down the connector. Margot planted her feet on the velcro patch next to Tom.

"Let's see if we can still get to the database," she said, as she reached over his shoulder for the keys. "We should be able to narrow down. . ."

Tom did not lift his gaze from the screen. "It's a fake, Margot," he whispered.

Margot's hand froze halfway to the keyboard. "What?"

"Little green men my ass," he spat toward the console. "It's a fake. It's Nick. He's doing this to try to keep us going."

Margot felt the blood drain from her cheeks, and the hope from her heart. "How do you know?"

"I know." For the first time Tom looked at her. "He'd do anything right now to keep us in line, to keep giving orders, just so it doesn't look like he's out of options like the rest of us mere mortals."

Margot looked at his wide, angry blue eyes and saw the man she'd served with swallowed up by another stranger. "You got proof?"

Tom shook his head, but the certainty on his face did not waver. "I checked the logs for gaps, suspicious entries, virus tracks, extra encryptions. Nothing. Nobody on this ship could have made an invisible insertion, except me, or Nick."

"Unless it's not an insertion," said Margot. "Unless it's really a signal."

Tom snorted and contempt filled his soft words. "Now you're talking like Jean. She hasn't been with it since Ed went. Be real, Margot. If E.T.'s out there, why isn't he knocking on the door? Why's he sending cryptic messages about comets instead of offering us a lift?"

"It's *aliens*, I don't know," Margot spread her hands. "Maybe they're methane breathers. Maybe they're too far away. Space is big. Maybe they want to see if we can figure it out for our-

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selves to see if we're worthy for membership in the Galactic Federation."

Tom's face twitched and Margot got the feeling he was suppressing a sneer. "OK, if it's aliens, how come I was able to figure out what they were saying so fast? They have a *NASA Machine Language for Dummies* book with them?"

Margot threw up her hands. "If Nick was faking this, why would he insist on a comm burst to mission control?"

Tom's jaw worked back and forth. "Because it'd look funny if he didn't and he knew Jean'd object and give him an out. She might even be in on it with him."

Margot clenched her fists. "It's a chance, Tom. It's even a decent chance, if we work the simulations right. It doesn't matter where the idea came from ..."

"It does matter!" he whispered hoarsely. "It matters that we're being used. It matters that he doesn't trust us to hear him out so he's got to invent alien overlords."

"So, report him when we get home," said Margot, exasperation filling her breathy exclamation.

"We're not going to *get* home," Tom slammed his fist against the console. "We're going to die. This is all a stupid game to keep us from killing ourselves too soon. He's determined we are not going to die until he's good and ready."

Margot leaned in close, until she could see every pore in Tom's bloodless white cheeks.

"You listen to me," she breathed. "You want to kill yourself? Hit the sick bay. I'm sure Paul left behind something you can O.D. on. Maybe you're right, maybe how we go out is the only choice left. But I think we can use the delta-vee from the comet to tow us into a tighter orbit. I'm going to try, and I may die trying, but that's my choice. What are you going to do? Which part of that stubborn idiot head are you going to listen too? Huh?" She grabbed his collar. "If it is Nick doing this, I agree, it's a stupid ploy. But so what? It's the first good idea we've had in over a month. Are you going to let your pride kill you?"

Tom swatted her hand away. "I am not going to let him treat me like a fool or a child."

Tom lifted up first one foot then the other. He twisted in the air and swam toward the connector. Margot hung her head and let him go.

Give him some time to stew and then go after him. She planted herself squarely in front of his station. "Reggie?"

"Functioning," replied the AI.

"We need to do some speculation here," she rubbed her forehead. "I need you to pull up any databases we've got on comets. Specifically I need any that are passing within a thousand kilometers of the *Forty-Niner*'s projected position anytime within the next several months."

A static burst sounded from the speaker as if Reggie were coughing. "Several is not specific."

"Six months then. Add in the possibility of a full or partial RCM burn for course correction to bring us within the cometary path. Can you do that?"

Two more quick bursts. "I can try," said Reggie.

That's all any of us can do right now.

"Searching."

Margot sat back to wait. She listened to the hum of the ship and the sound of her own breathing. No other sounds. She couldn't hear Nick and Jean down in engineering. She couldn't hear Tom anywhere. Worry spiked in the back of her mind. What if he was taking the quick way out? What if he was angry enough to take Nick out instead?

No, she shook her head. *Tom's just on edge. They're friends.*

Were they? She remembered the stranger looking out of Tom's eyes. Would that stranger recognize Nick? Would Nick recognize him? She glanced nervously over her shoulder. No one floated in the connector. She looked back at the screen. Reggie had a list up—names, orbital parameters, current

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locations, sizes, with an option to display orbital plots and position relative to the *Forty-Niner*. Highlighted at the top was Comet Kowalski-Rice.

Sounds like a breakfast cereal. Margot glanced over her shoulder again. The connector was still empty. The ship was still silent.

Kowalski-Rice was a periodic comet, with a nucleus estimated to be three kilometers long and between one and three kilometers wide. It had passed its aphelion and was headed back toward the Sun. Right now it was 2.9 million kilometers from the *Forty-Niner*, but it was getting closer. Margot brought up the orbital plot and did a quick calculation.

We burn fifty ... OK say sixty to be on the safe side, percent of the remaining propellant we can bring our orbit within seven hundred-fifty kilometers of the comet. Take about... She ran the equations in her head. She could double check them with Reggie or Nick, whoever turned out to be more reliable. *Bring us there in about a hundred and fifty-nine hours, with the comet going approximately two kilometers per second relative to the ship. This could work. This could work.*

Silence, except for the steady hum of the ship and her own breathing.

Margot swore. *This is no good.* "Reggie? Do you know where Tom is?"

"Tom Merritt is in the sick bay."

"No!" Margot yanked both feet up and kicked off the console. "Nick! Jean!" she shouted. "Sick bay! Now!"

She reached sick bay first. She wrenched the wheel around and threw the hatch open. A little red sphere drifted out toward her face. Margot swatted at it reflexively and it broke against her hand, scattering dark red motes in a dozen directions.

Tom had fastened himself to the examining table and sliced his throat. Clouds of burgundy bubbles rose from his neck, knocking against a pair of scissors and sending them spinning.

"Tom!" Margot dove forward and pressed her fingers against his wound. Panting, she tried to think back to her emergency medical training. *Dark red, not bright, oozing, not spurting, missed the carotid artery, cut a bunch of veins ... Tom, you idiot, you're so far gone you can't even kill yourself right.*

Events blurred. It seemed like Nick, Jean and Reggie were all shouting at once. A pad got shoved into her hand to help staunch the blood. The table was tilted to elevate his head. Reggie droned on clear and concise directions for covering the long, thin wound with layered sealants. Nick's and Jean's hands shook as they worked. Blood and tears stung Margot's eyes.

When they were done, Tom was still strapped to the table, unconscious and dead white, but breathing. The medical ex-system was obviously still working. Reggie had no problem reading from the various pads and probes they had stuck to him. It was giving him good odds on survival, despite the blood loss.

"Let's get out of here," said Nick. "We can vacuum this up when we've had a chance to catch our breath."

Jean didn't argue, she just headed for the hatch. Margot had the distinct feeling she wanted to crawl into a corner and be quietly sick.

Margot followed Nick and Jean out and swung the hatch shut. She wanted to be able to talk without getting a mouthful of blood.

"God," Nick ran both hands through his hair. "I cannot believe it, I cannot believe he did this." Unfamiliar indecision showed on his face. Margot turned her gaze away. Another stranger. Just one more. Like Tom, like the others.

No! she wanted to scream. *Not you. I know you! You recommended me for this mission. You have a great poker face and you sing country-western so loud in the shower the soundproofing can't keep it in! You keep all the stats on your kids sports teams displayed as the default screen on your handheld!*

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Your wife's the only woman you've ever been with! I know Nicholas Alexander Deale!

But she did not know the person torn with weariness, anger and doubt who looked out of Nick's eyes. The one who might be a liar on a scale she'd never imagined. How long before that stranger took Nick completely over?

Margot looked at Jean. Blood splotched her face, hands, hair and coveralls. Fear haunted her bruised-looking eyes. Fear brought the stranger. Jean would go next. The stranger would have them all. Tom was right. They were all dead. Only the strangers and Margot Rusch lived.

"What is it, Margot?" asked Nick.

What do I say? Which "it" do I pick? Who let the stranger into Tom? Me or you? She licked her lips. *Well, it does not get me. It does not get me.*

"Nothing." Margot grabbed a handhold and pulled herself toward the command center. "I'm going to find that comet."

After all, that was what the strangers wanted her to do. She had to do what they said. If she didn't. . .look what they did to Tom. Who knew what they'd do to her?

They do not get me.

"Here it comes, Margot," the voice that used to be Nick's crackled through her helmet's intercom.

Margot turned in her straps, and there it came. Actually, Kowalski-Rice had been visible to the naked eye for the past two days. The comet was ungainly and beautiful at the same time. A dirty snowball tumbling through the darkness surrounded by a sparkling veil fit for an angel's bride. It was huge—a living, shining island, coal black and ice white. Margot's hands tightened on the twin joy sticks that were the directional control for the explorer.

They had planned the maneuver out so carefully and modeled it so thoroughly. She had to give the strangers who walked as Nick and Jean credit. They were very good at what they did.

Jean's stranger had cobbled together the "harpoon" from drill shafts, explosives and hope. The grappling shaft had a timed explosive mounted on it and a solid propellant shell around it. When Margot pulled the pin, the propellant would ignite and burn for one minute to drive the harpoon to the comet. At one minute ten seconds the explosive would blow, driving the barbed head deep into the comet's hide. It had taken all of them to unwind and detach the mag sail cable from the drum and then rewind it, as if they were reeling in a gigantic fishing line. The very end of that cable had been welded to the harpoon using all the vacuum glue and tape Jean's stranger could lay her hands on. Jean's stranger had spent hours out on the hull, readjusting the tension on the cable drum so the pay out would be smooth.

Margot would launch the harpoon into the comet. The cable would pay out. Once the harpoon struck, the friction of the cable unwinding against the barrel would accelerate the *Forty-Niner*, and Margot in the explorer, which was tethered to the *Forty-Niner* by the cables that used to be the shroud lines for the mag sail. The more the cable unwound, the faster the ships would accelerate. Finally, the cable would run out. The comet would shoot forward with its leash trailing behind it, and the *Forty-Niner* and the strangers would fly free toward an areobraking rendezvous with Mars, and a rescue by NASA.

At least, that's what they said would happen. They might be lying. There was no way to tell. But if Margot refused to go along, they'd probably just kill her. She had to play. She had to act like she believed they were who they said they were. It was her only chance.

She tried to tell herself it didn't matter. She tried to believe what she'd told Tom, who they still, miraculously, let live, that it didn't matter who'd come up with the idea—aliens, the strangers, it

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didn't matter. If Nick and Jean, and Tracy and Ed, and Paul and even Tom finally were overcome by the strangers, it didn't really matter. What mattered was getting home. If she could get home, she could warn everyone.

But first she had to get home. She, Margot Rusch, had to get home.

"Better get ready, Margot," said Nick's stranger. "It's all on you."

So it is. And you hate that, don't you? I could mess up all your plans and you know it, but you can't get me. Not out here you can't.

Margot squeezed the stick, goosing the engine. Silently, her little frame ship angled to starboard, sliding gingerly closer to the wandering mountain of coal black ice and stone. Behind her, the three shining silver tethers that attached the explorer to the *Forty-Niner* paid out into the darkness.

She gave the comet's path a wide berth, but not so wide that she couldn't see how it lumbered, turning and shuddering as sparkling jets shot off its pocked hide.

I can do this. How many asteroids did we skirt? They were all falling too.

But not like this. She imagined the comet hissing and rumbling as it dashed forward. *They're making me do this. They don't care if I die.*

Black specks dusted her visor. She wiped at them. She glanced behind to see that the tethers were moving smoothly. The comet was almost in front of her. Black ice, black stone and the sparkling white coma surmounted the darkness.

Suddenly, the rover shuddered and Margot jerked in her straps. A stone careened off the frame ship and shot past her head.

That was a warning shot. That was them ... No, no, they can't get me out here, but the comet can. Keep your mind on the comet, Margot. Don't think about them.

The *Forty-Niner* was below and behind her now. The comet was receding. The coma filled the vacuum, shining like a snow blowing in the sunlight. Margot pitched the rover up and around, until the comet was flying away from her, but she was not in the thick of its tail.

For a moment, she was nothing but a pilot and she smiled.

Perfect deflection shot. Fire this baby right up its tailpipe.

The strangers had mounted the harpoon on the explorer's fore starboard landing strut and attached the launch pin to the console. Margot fumbled for the thick, metal pin and its trailing wire.

Well, just call me Ishmael, she thought, suppressing a giggle. *There she is, Captain Ahab! There be the great white whale!*

"Margot ..." began Nick's stranger.

"Don't push," she snapped. *Don't push. I might decide not to do this.*

I could. I could not do this. I could leave the strangers out here. Never have to bring them home. Never have to hurt my friends families by showing them what's happened.

But I want to go home. Forgive me, Carol. Margot Rusch has to get home.

Margot grit her teeth. Ice crystals drifted past her. The comet retreated on its lumbering path, inanimate, or at least oblivious of their presence and their need.

Margot pulled the pin on the harpoon.

The recoil vibrated through the frame. The harpoon shot forward, hard, fast and straight. The tether vanished into the thick of the coma, lost in the shining veil of ice.

A jet of ice crystals exploded into the night. The comet rolled away as if wounded. The tethers on their reel played out into the void. Margot bit her lip. The tether was the key. If it released too fast, got tangled, or broke, it was over, all of it.

"Margot! Report!" demanded Nick's stranger.

"Tether holding steady," replied Margot reflexively. "Pay out looks good."

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You'll get home. To Nick's home. That's what you care about.

The explorer shuddered. A sudden intense cold burned Margot's shin. A red warning light flashed on her visor screen.

No!

A black gash cut across her gleaming yellow suit. The joints at knee and ankle sealed off automatically. Margot fumbled for the roll of sealant tape on her belt. As she did, the explorer began to slide backward, away from the comet, toward the *Forty-Niner* to the limit of the tether. The movement dragged her back against her straps. Her glove gripped the tape reel. Pain bit deep.

Hang on, hang on. Lose the tape and you're gone. You're all gone. The stranger'll have you if you lose the tape.

The tug grew stronger. Margot felt her body shoved backward to the limits of its straps. A weight pressed hard against her ribs, her throat, her heart. After years of zero *g*, the acceleration gripped her hard and squeezed until her breath came fast and shallow.

Ahead of her, the *Forty-Niner* began to swing. A slow, sinuous movement that transmitted itself along the tether. It pulled the explorer to starboard, tilting her personal world, confusing her further, adding to the pain that screamed through every nerve.

Slowly, slowly she pulled the roll of tape from her belt. She grasped it in both clumsy, gloved hands. The explorer shimmied. Her body bounced up, then down, hard enough to jar her. The tape slipped. Margot screamed involuntarily and clung to it so hard she felt the flimsy reel crumple.

"Margot?" Jean's stranger. "Margot? What's happening?"

"Don't unstrap!" came back Nick's stranger. "Jean, stay where you are."

Right, right. Why risk anything for me? I'm not a stranger.

She leaned forward as if leaning into a gale wind. Black spots danced in front of her vision. She saw red through the gash, as if her leg glowed with its pain. She jounced and shuddered. More hits. The explorer was taking more hits from cometary debris. She couldn't steady her hands enough to lay down the tape.

Margot bit her lip until she tasted blood. She pressed the tape reel against the black gash, pushed the release button down and pulled, hard. A strip of clean white tape covered the black scoring.

The red light on her suit display turned green and the joints unsealed. Her suit was whole again.

Margot let herself fall backward, gasping for air, gasping for calm against the pain. Her left leg from ankle to knee would be one gigantic blood blister. But she was alive. The stranger hadn't got her yet. She hugged the tape to her chest. The *Forty-Niner* started swinging slowly back to port. Gravity leaned hard against her. Her heart labored, as if trying to pump sideways. Her stomach heaved. Her whole body strained against the straps.

She closed her eyes and tried to reach outward with every nerve, trying to feel the clamps and catches as she could her fingers and toes, wishing she could hear something, anything, a straining, a snapping. All there was was silence and the unbearable pressure driving her ribs into her lungs.

"*Forty-Niner* to Explorer One." Nick's stranger. What did he want? To find out if her stranger had swallowed her yet?

Not yet, Sir. Not yet.

"Margot? Margot, it looks like you're venting something. Report."

Venting? Margot's gaze jerked down to the monitor between her flight sticks. Red lights flashed. She didn't need to read the message. The diagram showed everything. The methane tank had been hit and all her fuel was streaming out into the void, leaving nothing at all for her to use to guide the explorer back to *Forty-Niner*.

She was stuck. She would hang out here until her air ran out. She was dead all over again.

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All at once, the vibrations ceased. She was flying smooth and free, gliding like a bird on a sea wind with only the most gentle roll to perturb her flight.

"We have tether release!" cried Jean's stranger.

Margot looked up. A silver line lashed through the clean, sparkling white of the coma.

Tether release. They'd done it. It had worked. The strangers were all on their way home. She looked again at her own fountain of crystals streaming out behind her, a comet's tail in miniature.

That roll'll get worse. They'll have to correct for it. They'll have to fire the rockets and catch me in the blast and tell Jordan and mission control how sorry they were.

Nick's stranger spoke to her again. "Margot, we gotta get you in here. If your fuel's gone, can you haul on the tether? Margot?"

"She's not receiving, Nick. The headset must be out. I gotta get down there."

All gone. Nothing to do. Pain throbbed in her head, crowding out her thoughts.

"Margot, pull!"

She couldn't move. Pain, bright and sharp, burned through her. All she could do was watch the crystal stream of her fuel drift away into the vacuum.

Margot Rusch is dead.

"Margot! Answer me! Pull, Margot!"

She's been dead for weeks.

"Come on, Margot. I got a green on your headset. Now answer me, damnit!"

The stranger wins. She got Margot Rusch after all.

"She didn't even get a chance to say good-by to Jordan. That's the bad part," she murmured.

"Margot?" came back the voice of Nick's stranger. "Margot, this is Nick. We're receiving you. Acknowledge."

Why are they still calling her Margot? They must know the stranger had her by now. She would have liked to know the stranger's name. Maybe she wouldn't mind burning to ash when they fire the correction burst. Margot Rusch certainly wouldn't mind. Margot Rusch was dead.

The explorer jerked. Mildly curious, Margot looked toward the *Forty-Niner*. A figure in a bright yellow hard-suit leaned out of the ship's airlock. Its hands hauled on the tethers, as if they were hauling on curtain cords. The *Forty-Niner* drew minutely closer and the pair of ships began to spin ever so gently around their common center. Margot felt herself leaning against the straps.

"Margot Rusch!" Nick's voice. Nick's stranger? A quick burst fired from the *Forty-Niner*'s port nozzle. The spin slowed.

"Margot Rusch, wake up, you stupid fly-jock and pull!" Jean now. Jean's stranger? Jean's stranger trying to save Margot Rusch's stranger?

Jean trying to save her? But she was dead, she as dead as Ed and Paul and Tracy and Tom.

No, not Tom. Tom's still alive.

What if I'm still alive?

Cold and pain inched up her leg and emptied into her knee, her thigh. Her head spun. Readings flashed in the corner of her helmet. The suit had sealed itself. Blood pressure was elevated, respiration fast, shallow, pulse elevated. Recommend termination of EVA.

"Margot Rusch, help her get your butt back in here!" shouted Nick.

Margot leaned as far forward as the straps would let her. Her gloved fingers grappled with the tether and snared some of the slack. Margot pulled. The *Forty-Niner* came a little closer. The suited figure became a little clearer.

"I knew you were still with us!" cried Jean, jubilantly. "Come on, Margot. Pull!"

Margot pulled. Her arms strained, her joints ached. Her suit flashed red warnings. The *Forty-Niner* moved closer. The spin tried to start, but another burst from the engines stalled it out again. Margot's breath grew harsh and echoing in the confining helmet. Her lungs burned. The cold pain reached her hip

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and started a new path down her fingers. The *Forty-Niner* filled her world now, its white skin, its instrumentation, its black stenciled letters and registry numbers.

And Jean. She could see Jean now, hauling on the tether as if it was her life depending on it. She could even see her eyes. Her eyes and herself, her soul, looking out through them. Margot knew if she looked at Nick she would see him too. Not strangers, not anymore. Maybe not ever.

They had done what they had done. Maybe Nick had faked that message, maybe they'd had help from unknown friends. They'd sort it all out when they got home. What mattered now was that they would get home, all of them, as they were. Not strangers, just themselves.

Margot grabbed up another length of tether and pulled. ■

IN TIMES TO COME

Our November issue covers a wide spectrum of both length and content, from Michael A. Burstein's novella (whose starting situation and characters will be familiar to readers who remember his popular "Broken Symmetry" and "Absent Friends") to Shane Tourtellotte's "Probability Zero" tale about "Messengers." Between those extremes we'll have stories of all shapes and sizes by such writers as F. Alexander Brejcha, Grey Rollins, Pete D. Manison, Ron Goulart, and Brian Plante.

The prolific Stephen L. Gillett, Ph.D., supplies the fact article, with the tantalizing title "Diamond Ether, Nanotechnology—and Venus." If you're reading this magazine, you likely have at least a passing acquaintance with several methods that have been suggested that might be used for terraforming Venus. What you may not know, but as Dr. Gillett will explain, many of those ideas look considerably less promising on close examination than at first glance. But yes, he does have an alternative suggestion; and it is, as the saying goes, something completely different. . . .

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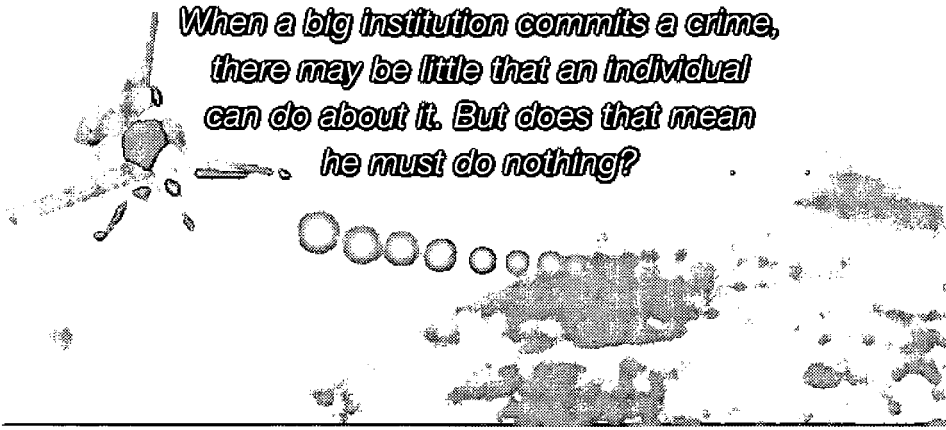
Ron Collins

STEALING THE SUN

When a big institution commits a crime, there may be little that an individual can do about it. But does that mean he must do nothing?



Alpha Centauri A was chosen for a few very simple reasons. First, it was close—a mere 4.3 light years from Earth. Second, it was a G2-type star, similar enough to the sun that data taken directly from Sol could be used in software models without requiring complex conversions.

But the most important factor was greed.

Each star in the Centauri system had adequate fusion material to support the new propulsion systems, but Centauri A was the largest of the three, with a mass ten times that of Proxima and twenty percent greater than Centauri B. The supply of resources in A would last that much longer.

And in the end, that was the factor that doomed the star to an accelerated death.

Lieutenant Commander Torrance Black stood on the gunmetal runway that circled *Everguard*'s pod engineering assembly area. The rail was cold against his grip and seemed to adhere to his palms. Machinery ozone seeped through the open grate of the floor and hung around him like an acrid memory, unchangeable but vaguely distant.

Everything appeared to be on plan.

Each tube bay stood open, the collection forming a perfectly spaced row of a dozen chambers, their three-meter-diameter spans empty, pristinely round, and gleaming with stainless steel beauty.

The wormhole pods that went into these tubes were the size of G-class riders—fifty meters tip-to-tip but rounded in cross-section to fit into the circular tubes. Their surfaces were coated with rugged brown thermal material that made them appear starkly utilitarian in the brightly lit assembly area. Each end was capped with conical black boots of heat-treated alloy, and banded with a titanium-steel ceramic composite fashioned in the zero-g environment of Armstrong station.

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His staff wore their fresh whites today. Their voices echoed with professional bearing in the open expanse. A computer reported the status of the automated routine that controlled much of the launch sequence.

"I want these tubes loaded by 1800 hours, folks," he barked at them with what, even he realized, was a little too much vinegar.

"We'll make it, LC," Malloy replied with a quick salute.

Torrance returned the gesture halfheartedly, then stepped into his glass-enclosed office. He settled into his chair, sighed, and stared through the computer's holographic image of the wormhole pod's internal guts.

LC. The title echoed in his mind like silence after an angry scream. Lieutenant Commander.

That was the thing about rank in the military.

Everyone understood what a rank meant. Rank labeled a man, and it stayed with him. It would not be long before the promotion list was made public, not long before everyone knew where Torrance stood.

He would change the world today. As chief launch engineer, he would release a dozen wormhole pods that would burrow into Centauri A. Their external shells would burn rapidly inside the star's core, and if at least nine of the twelve systems made it to the target point, they would rend space and create the far end of a wormhole. Raw hydrogen and helium would flow to the other side where fellow servicemen would latch these extradimensional warps to the back end of starships.

Then the universe would be open for the first time.

FTL. Faster-than-light travel. Sirius for breakfast, Aldebaran for dinner.

He supposed he should feel something appropriate.

But Kip Levitt, commanding officer of the ship's Propulsion Center, and a man Torrance had gone to school with so many years ago, had been promoted to full commander today.

Torrance had not.

And it didn't take a lifer to know that when a man in the chain of command is passed over for promotion, his career, for all effective purposes, is over.

The comm light flashed green on Torrance's desktop.

"Messages, please," he said.

The image of one of his ensigns filled the desk's primary view screen. "All tubes loaded, and the power system is charged, sir. Final prognostics are running now."

"Thank you," Torrance replied, "I'll be there in a minute. We're on hold until the admiral arrives."

"Aye, sir, I'll tell Lieutenant Malloy."

The display returned to software circuitry Torrance had been working with prior to the message. He pressed a control pad and accessed data from the propulsion system. Green numbers read three hundred plus terra electron volts. A collider ringed the ship at a radius of fifty-three kilometers. Outside the observation panel, Centauri A's light made it a gleaming sliver of silver against the black velvet sky.

Torrance grimaced, thinking about the particles inside the ring with something akin to jealousy.

They were lucky, he thought.

Their fate was revealed on a time scale of picoseconds.

Torrance sighed.

Every member of the pod crew, including Torrance himself, filled other jobs during the flight and would be reassigned back to them during the trip home. For example, Lieutenant Karl Malloy, his chief operations officer, was a nav analyst second class, a job that amounted to gathering data for shipboard navigation controllers. When he wasn't in charge of probes, Torrance was the chief service engineer, responsible for resolving problems with anything from fried communications systems to

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stopped-up toilets.

Not exactly glamorous.

But then he supposed that could be said about his entire career. He had never been one to seek out the limelight—like Kip Levitt. He hadn't been a football hero at the Academy or a leading officer candidate. He didn't grab control in survival school in times of emergency. Instead, Torrance faced difficult times by immersing himself in work, filling his thoughts with code so that his brain didn't have time to spin out of control over something it could not change. Hell, the entire *Everguard* mission was just another case of burying his head in the sand.

He rose from his upholstered chair, and stepped around his curved desk to walk into the main assembly area. At the same moment, the entry doors dilated, and Admiral Hatch entered with a full escort of petty officers and assistants, including Torrance's CO, Captain Alexandir Romanov.

"Admiral on the floor," Torrance shouted briskly and presented a stiff-backed salute.

"As you were," the admiral replied.

The admiral was an older man with brown hair that showed gray at the razor line of his nonexistent sideburns. His green eyes sparkled, and he walked with an efficient stride that spoke of attention to detail and purpose of mind. "What is our status, Lieutenant Commander?"

"Green for launch, sir."

"That's good. Your men are a credit to the service, Torrance."

"Thank you, sir," Torrance replied, glancing toward Captain Romanov.

Romanov smiled. "Indeed you are."

The captain's presence sizzled against Torrance's mind. *Indeed you are.* What bullshit. Without doubt it had been Romanov, a rigid, by-the-book-at-all-costs type of man, who allowed the promotion billet to pass Torrance by.

The staff worked in the area below them, checking status displays and ensuring every firing assembly, safety release, and navigation system was operational. They closed the hatches of each tube, leaving behind a dozen anodized black discs evenly spaced along the curved wall like rounds in an old Remington Colt.

Power surged in the launch system. Twelve external launch doors dilated open with the recognizable groan of hydraulic pressure.

"Ten seconds to engage," a recorded voice echoed the red readout that hung on the wall.

Torrance's spine tingled. He thought about his mother and father, and he wondered how they were. With the time it took message traffic to travel from Earth to *Everguard*, it was possible they were no longer even alive. He had never *really* thought of that before.

The digital readout said *seven*. The power coils whined as they sucked energy from the collider.

The image of Cal McKinley, a high-school friend, came over him. His years at the Academy, his first posting under Captain Jao. Torrance had worked through the ranks, receiving solid commendations at every posting. But at LC there were only so many positions above him.

And Romanov was by-the-book.

The readout read *five*.

Now Torrance's entire life was wrapped up in twelve wormhole pods.

Three.

The crew monitored the launch process. Software controllers ran on optical processors.

For the first time in a long while, he thought of Adrienne.

Everguard traveled at nearly six-tenths the speed of light, translating into a twelve-local-year round-trip flight.

Two.

He would be forty-one when the mission was complete. The effects of time dilation would have aged the rest of the world three years beyond that. His investments would likely have doubled

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twice—not that there was much left after the divorce, but it should be enough to live on for a while.

One.

At least that was something.

"Launch initiated, sir."

Silence echoed where there should have been thunder. The compartment held its breath.

"What's wrong?" the admiral asked.

"I have no idea, sir," Torrance replied, his heart growing cold. "But the pods are not away."

"We're not getting anywhere, sir," the technician said.

"And your point would be?" Torrance snapped back.

The air was stale with day-old sweat. The staff was tired and defeated. Their mission-day whites hung from their bodies like whipped flags in dead wind. Displays of the launch system's microcircuitry and software execution paths flickered against glass boards.

It was 0300 and still they had no answers.

"I'm sorry," he said, rubbing cheeks that were plastic with fatigue. "I'm just like you guys, though—really frustrated, and even a little angry. Romanov wants a personal report at 0600, so I'll admit I'm anxious to get to the root of this. I apologize for snapping, all right?"

All around, the staff nodded.

"Maybe Romanov would like to take a ride in the tube to check it out personally," Malloy said with a grin, his eyebrow raised in mock anticipation. "We could probably arrange an inspection."

The collection of men and women chuckled, and the room loosened noticeably. Lieutenant Malloy had a knack for saying the right thing at the right time. The image of Romanov as an icon for the upper command structure, drifting out into space from a derelict launch tube, made everyone smile.

Torrance took a deep breath. "Maybe the answer isn't here."

"What do you mean, LC?"

"We've been over everything three times. If the problem were in the onboard systems, I know we'd have found it by now. Maybe it's something outside."

"Like what?"

Torrance scratched his cheek, fingering overnight stubble. "I don't know. How about we run the full spectrum of sensor scans again, OK?"

"Did that when we got here, sir," Malloy replied.

"I know," Torrance said. "But maybe we missed something."

Malloy nodded. "OK, LC. We'll do it."

The crew stood to get to work.

"Finish the scan," Torrance said, with a grin. "Then I order you all to turn in for the night."

Scientists studied the Centauri system for decades prior to *Everguard*'s launch. They listened for signals and imaged it with deep-space telescopes. They scanned with radio interferometers, looking for telltale wobble.

It was Mars station that finally discovered three planets orbiting A and two that orbited B. Only the second planet from Centauri A, however, was inside the zone where liquid water—and thereby intelligent life—was possible.

Scientists quickly dubbed the planet Eden, but closer study soon determined it to be anything but.

Its atmosphere was a horrific mixture of methane, carbon dioxide, and sulfuric acid that had created a runaway greenhouse effect similar to that of Venus. In addition, models suggested that extreme tidal forces of the Centauri tri-star system would heat the planet's core and make for a volcanic world with a stormy weather pattern that continually raged across the surface.

The search for intelligent life, they said, would have to dig deeper into the universe.

The good news was that it wasn't his fault.

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It was 0515. Torrance was early, but he knew his CO would be out of bed.

Trying to relax, he rang his CO's bell.

"Romanov here." The captain's voice was alert and responsive through the intercom.

"Lieutenant Commander Black, sir."

The door buzzed softly, then dilated open.

The ventilation system blew a cool breeze that made the back of Torrance's neck crawl. The room was quiet, decorated with a row of flat-panel images of starships and other vehicles. Romanov was fourth-generation military, and his compartment showed it. The far wall, though, carried a holo of a waterfall from the backlands of Maui. A glass table with three chairs sat in the corner of the room.

The captain rose from his meditation pad, dressed in a loose robe of red terry cloth. A thin film of sweat glistened from the curve of his collarbone.

"Good morning, Captain," Torrance said.

"I think it is acceptable to be informal before 0600, Torrance," Romanov said with only a trace of his Russian heritage in his accent. He gestured toward the table. "You look as if you've had a very long night. Have a seat and tell me what you've found."

Torrance sat down, not certain how to start. The captain sat across from him.

"We have a problem."

"Yes?"

"When *Everguard* opened the launch doors we encountered an electromagnetic disturbance."

"I see no problem, then. Just shield what we need to shield and let's get on with it."

"It's not that simple."

"Why not? We've got inventory."

"Yes, we do," Torrance admitted. "But the disturbance is coming from outside."

"Outside of what?"

"Outside of *Everguard*, sir. It's coming from the star's second planet."

Romanov thought.

"Why didn't it show up in our scan?"

"I checked the logs. It was there, but the configuration of the planets and the star cut the amplitude of what we received, and we overlooked it." Torrance didn't need to add that the *we* who *just overlooked it* did not include either Torrance Black or Alexandir Romanov.

"I see." The captain clasped his hands together and leaned against the table. His gaze bore into Torrance. "So, you're thinking that a stray burst of EMI says there may be life on Eden?"

"I don't see how we can read it any other way."

"Despite the fact that all our examinations confirm the planet's atmosphere is toxic?"

"Only a lifeform could produce this EMI."

"The planet is a perpetual storm," Romanov said. "It is certainly possible that such a place could generate high-energy disturbances, is it not?"

"What we've received has been tight, Captain, not random white noise."

"Have you run our translator programs?"

"Yes."

"And?"

"Nothing yet, sir. But just because we don't recognize a pattern doesn't mean one can't exist. Our linguistic code should be reviewed before we go any further."

The ventilation system wheezed like the collected mumble of distant voices.

"Lieutenant Commander." The captain's voice became firm, and Torrance realized the discussion had just become formal. "We have a mission to accomplish. What you've found is not enough to warrant a jump to the conclusion of intelligent life when everything else we know to be true discounts that."

Torrance froze. He had expected Romanov to point the finger of blame to the External Sensor Command and postpone the mission. But now the captain seemed more determined than ever to

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push forward.

"What if I'm right, Captain?"

"I don't think that is the case."

"But, sir, if this *is* intelligent life, draining their star will leave them without energy. Whatever civilization exists here will die."

"I understand, Torrance," the captain said, his eyes blazing like dark lasers. "But even a simple trip planetside could cost us a year both ways. And who knows what we would find? Probably nothing but static-generating clouds. Do you want to hold back our understanding of the entire universe because we piddled around looking for thunderstorms in Eden?"

Torrance did not reply.

"You're a good man, lieutenant Commander," Romanov continued. "You've always been a part of the team. You're a hard worker. When the going gets tough you stick your nose into the guts of our problems and figure out how to make things work. It's a trait I most admire in you. I know I can rely on you to do what's right for us in the big picture."

Suddenly, Torrance understood.

This was about position. It was about expectations and power. If they diverted for a false call, the careers of every officer aboard would hang in tenuous balance. Torrance's stomach burned, reminding him that the last thing he had eaten was the synthesized roast beef sandwich he had for lunch yesterday.

"Thank you, sir," Torrance said, more because it seemed he should than because he felt anything.

"I do understand your concerns," the captain said. "I'll take your report to the admiral for his confirmation of my order. But our mission here is clear. I have a duty to the people of our solar system, as do you.

"Those tubes need to be shielded and another launch profile prepared as soon as possible."

"I understand," Torrance said, standing.

He understood, yes. But a cold stone formed in his stomach. The captain had just supported potential genocide of what might be an intelligent species of creatures in the name of human longevity, and he had done so with barely a second thought.

"Thank you for your work, Lieutenant Commander," Romanov said.

Torrance sighed, giving into the weight of the waves crashing around him. "The staff had a late night, sir. I've ordered them to their beds. But I think we can be ready to launch in roughly twenty-four hours," he replied, saluting.

"Very good. Looks like you could use some sleep yourself."

"Yes, sir."

Torrance turned and strode out of the captain's office, his temples suddenly throbbing with a massive headache.

Torrance and Adrienne met right after he had entered the Academy. At quiet times he still thought about their wedding day, the sugary whiteness of their cake, Adrienne shoving an overly large bite into his mouth. He remembered buying their first house.

They had wanted children—Adrienne pushing for three, Torrance thinking more like ten.

But children never came.

A series of trips to fertility doctors eventually found he was the problem.

There were solutions, of course. Adoption, or donor transplants. Gene therapy. But at the time, Torrance was adamant. He couldn't raise someone else's children. Torrance didn't care that everyone else in the world was doing it. It wasn't right, and no gene therapy in the world could change the fact that every time he looked into the child's eyes he would see his own failure.

He had been scared and embarrassed.

And like usual, he had ignored the problem, letting it fester until it grew black and malignant.

They split a couple of months before the *Everguard* opportunity arose. Without Adrienne in his life, he found he

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needed something to focus on, something to throw himself into to take the pain away. All he had at hand was the military, with its structure and its rules that dictated what to do when and how to do it. He was suited to this environment, he realized. He felt comfortable with the service, understood how it was supposed to work.

The idea of twelve years aboard the *Everguard* had seemed so perfect.

The staff wore their workday blues this time.

They placed shielding around the most sensitive of the firing system's components. Torrance stared into the blackness of space. In less than two hours he would give an order that would expand his world, arguably saving it when looked at over millennia, but might doom another. The thought bubbled thickly in his gut.

He never asked for this.

His career was likely over. He would return to his own world tired and used. A forty-one-year-old man with no family, no future, and no dignity.

It was the last that twisted in his gut with an edge like a serrated hunting knife.

Deep down, Torrance knew his analysis was right. The signal was strong and cohesive. It was a message, but in a language their translator code had been unable to crack. There was life on that planet, and no argument the captain or anyone else aboard this ship could put forward would convince Torrance otherwise.

His uniform collar seemed tight against his neck.

The decision to launch the pods made him sick—made him feel exposed and dirty. He had twelve buttons to push. He was one commander. Twelve wormhole pods. One sun. One people with unknown technology.

Unknown technology, he thought. But technology at least advanced enough to release emissions that interfered with *Everguard*'s systems. Torrance's heart beat with the sudden change of pattern that let him know he was on to something. An idea dawned, a thought that gnawed at him like a rodent trying to claw out of his belly.

One technology.

Energy tickled his spine. It could work, he realized. Competitive reengineering had fueled human progress for centuries. It was a huge personal risk, though, with what was left of his career at stake.

He gazed out of the observation panel.

The collider glimmered against black velvet.

Protons and neutrons raced inside the ring, scattering themselves into the netherworld of quarks and leptons—universes that lived and died in fractions of seconds. A collector gathered each of these particles, separating them and funneling each into channels where supercooled electromagnets ensured they would find their antimatter counterparts.

The resulting meeting of matter and antimatter pushed energy into the ship's propulsion unit. Soon a small fraction of that power would be funneled off to feed the launch tubes.

Torrance closed his eyes, listening to the ship. It was a sound he loved, a gentle hiss, soft and warm, reminding him of the wind that had blown past his open window when he was a teenager in Wisconsin.

That was a long time ago.

Lives, like military careers, can be made in the span of a single collision of a neutron and a proton. And they can be broken in similar time.

Or they can merely fade away, decaying like radioactive waste with a half-life of a human being.

It was time, Torrance realized, feeling truly comfortable for the first time since he could remember.

He knew what he had to do.

"Fifteen seconds until launch," the

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mission controller said.

Again the admiral stood at Torrance's side. The power coil moaned. Switches clicked and firing systems armed.

The countdown clock read *ten*.

Twelve probes stood ready to forge the link that would give the human race the ability to explore millions of stars.

Five.

Torrance pursed his lips, feeling oddly proud. He had done his best, and that was all that any God—or any commander, for that matter—had the right to ask of any man. Perhaps it wouldn't be enough. But perhaps it would. And *that* was sometimes the most that any man could ask of himself.

Two.

One.

"Launch sequence is initiated," the controller replied.

The pods thrust against *Everguard*'s hull like the strikes of twelve sledgehammers. A dozen flaming arrows sliced through black space in formations of four.

One group fell toward the star, then another.

Then the last.

A single element of the last, however, edged off course, twisting slightly.

Adrenaline leapt through Torrance's body with the pod's initial lurch, and he stifled a proud smile. His calculations had been rapidly done, and the reprogramming had been equally hasty, but he knew this code like the back of his hand. If he got it right, the pod would land somewhere on the second planet.

With luck, whoever was there would look at it, would examine its circuitry and its propulsion system. With their new knowledge they might learn how to engineer spacefaring vessels themselves.

And they might find a way to save themselves.

The pod turned, rolling off the original flight plan and heading away from the sun.

"What's wrong?" the admiral said.

"I'm not certain, sir," Torrance replied before Captain Romanov could. "But I'll run a full investigation. The good news is that we have eleven birds on course and heading for home. We only need nine to be successful."

Romanov stared at Torrance, seeming to note the grin that rode his face. But he did not say anything.

Of the remaining pods, one lost power and drifted slowly toward the star, pulled to a fiery death by Centauri A's gravity well. The rest stayed on course, and pierced the star's surface. Thermal shielding held back the heat for the milliseconds each electronic package needed.

The wormhole actuators engaged.

Energy, hydrogen fusing to helium, began to flow.

Captain Romanov sat at his glass table, waiting patiently as Torrance entered. A cup of coffee and scraps of the captain's dinner sat on the table.

"You wanted to see me, sir?"

Romanov gestured toward an empty chair, and Torrance sat.

"That was a gutsy move, Torrance."

"I beg your pardon?"

"I've examined the preflight records. The last probe's navigation software was altered."

Torrance considered denying it, but could see firmness in his CO's eyes. "They deserved a fighting chance, sir."

The captain nodded. "Deliberately altering a mission profile without authorization is a trick that can get a man court-martialed."

Silence reigned for several heartbeats.

"We're stealing their sun, sir," Torrance finally said. "I figure they've got maybe ten thousand years before their planet gets too cold to support life. If they're of advanced technology, they'll be able to study the pod and maybe save themselves."

"And if they're not?"

Torrance stared into a wall scene of

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the Ural Mountains and waited for the captain's other shoe to drop. He wondered if it would be court martial, or merely some form of censure. Certainly he would lose at least one rank.

"You don't have a family, do you?" Romanov said.

"My parents live in Wisconsin."

"I mean children."

Torrance furrowed his brow. "No, sir. No children."

Romanov gave an indecipherable grunt and absentmindedly fingered his coffee cup. "I'm sorry you were passed over for promotion, Torrance. You're a good man. But we have only so many billets."

"Thank you, sir."

"You've always worked hard. It is a long flight back home. A lot of good things can happen to a man who works hard for six years."

Torrance stared at his CO, who sat back in his chair and regarded him openly. Alexandir Romanov's brown eyes told him everything Torrance needed to know. Romanov had made a snap decision. But he had understood its importance, and he had looked in the mirror since that moment knowing the extinction of a race might go against him in the end.

Now the future of that unknown species rested in a wormhole pod that was speeding off into space.

"I am thinking," the captain said, "that the report I give the admiral should describe a technical problem with the guidance software of the twelfth pod."

Torrance smiled.

"That could be done, sir."

The captain nodded. "Then make it happen," he said.

Lieutenant Commander Torrance Black walked briskly into his office. He needed to prepare a report, and he needed to think about his life, to plan.

He had six years aboard *Everguard*, and if any man could get back on the promotion path, it was going to be him.

And if he didn't, well . . .

There were options.■

We welcome your letters, which should be sent to *Analog*, 475 Park Ave. South, New York, NY 10016. (email: analog@ dellmagazines.com.) Space and time make it impossible to print or answer all letters, but please include your mailing address even if you use e-mail. If you don't want your address printed, put it only in the heading of your letter; if you do want it printed, please put your address under your signature. We reserve the right to shorten and copyedit letters. The above e-mail address is for editorial correspondence *only*—please direct all subscription inquiries to: P.O. Box 54625, Boulder, CO 80328-4625 or smarlowe@pennypublications.com.

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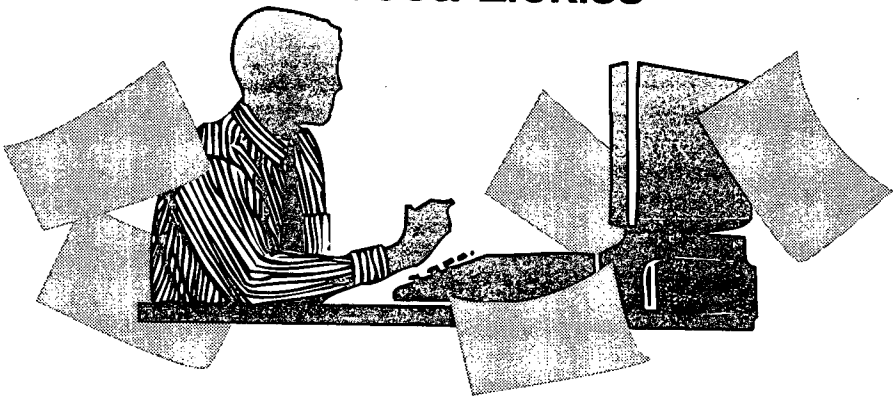
The Right Hand and The Left Hand

Rebecca Lickiss



Bureau of Identification
National Identification Database
Washington, D.C.
15 July 2017
Dear Sir or Madam:

This is to inform you that I am still alive. An error indicating that I am dead has somehow slipped into your system. Please update your database.

Thank You,
Mr. Simon Andrews

Bureau of Identification
National Identification Database
Washington, D.C.
2 September 2017
Dear Sir or Madam:

My wife received your computer response to my last letter. She was not amused. No one, other than myself, is trying to use my name and ID. I am not dead. I have a doctor's certificate (enclosed) to prove it. If you require any further documentation of my continued existence, please let me know. I only want you to correct an error in your database, and am willing to provide you with whatever proof you need.

Thank You,
Mr. Simon Andrews

Bureau of Identification
National Identification Database
Washington, D.C.
31 October 2017
Dear Sir or Madam:

My HMO, my doctor, my employer, my wife and all my creditors received your last notice. My insurance company has cut off all benefits, because you told them I was dead. My doctor regrets to inform me that he can no longer treat my high blood pressure, because since you insist I am dead my insurance will no longer pay for my treatment and he can't accept money for independent treatment, since he would lose his credentials. My employer can't employ me, because you say I am dead. My creditors wish to receive full payment from an es-

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tate that doesn't yet exist. My wife and I can't afford to pay them unless she receives her widow's benefits, which she can't get until she sends in a certified copy of my death certificate. I can't get a doctor to give me a death certificate, since I'm still breathing.

Enclosed is a certified copy of the doctor's certificate I sent you last, notarized by a duly authorized notary who saw the letter, me, my birth certificate, driver's license and National ID Card. Please correct your database error.

Thank You
Mr. Simon Andrews

Bureau of Identification
National Identification Database
Washington, D.C.
4 January 2018
Dear Sir or Madam:

I am still alive. I refuse to be dead just to make your database correct. Isn't there anyone human in your bureau? Won't you please check this out? I swear I'm still alive. PLEASE CORRECT YOUR DATABASE!

Thank You,
Mr. Simon Andrews

Bureau of Identification
National Identification Database
Washington, D.C.
27 February 2018
Dear Sir or Madam:

I AM ALIVE! Correct your database, you scum-sucking bureaucratic worms!! I refuse to be dead due to computer error!!! I'm not normally violent or prone to fits of extreme hostility, but if you don't do something about this I can't be held responsible. After all, you say I'm dead!! CORRECT YOUR DATABASE ERROR!!!!!

Thank You,
Mr. Simon Andrews

Bureau of Identification
National Identification Database
Washington, D.C.
15 April 2018
Dear Sir or Madam:

A few weeks ago, I realized that I would have some trouble paying my taxes, because you insist I am dead. So I went, in person, to the local IRS office. Luckily they believed me. At first they didn't know what to do, and I was passed up the chain of command to ever higher levels of officials. Then a very bright state supervisor saw some potential in my situation. After all I can go anywhere, do anything, and what's anyone going to do? The records show I'm dead. The IRS now has its very first living-dead agent. My creditors are paid off. My doctor is very cooperative. My wife is no longer wondering if things would be better if she left me. You did not succeed in destroying my life. Too bad.

Within the next few weeks everyone in your department will be receiving Notices of Audit. If your database at work is this riddled with errors, what must your home records be like? I look forward to meeting each of you live-person to dead-person.

Thank You Very Much,
Mr. Simon Andrews, deceased.■

Common sense does not ask an impossible chessboard, but takes the one before it and plays the game.

— Wendell Phillips

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A CENTURY OF PHYSICS

In March 1999 the American Physical Society (APS) held its 100th Anniversary Meeting in Atlanta. It was the largest such physics meeting ever held, with an attendance of about 11,500 physicists, most of whom gave contributed or invited papers, with as many as 60 sessions of papers being presented at the same time. Of course, it's impossible to try to capture the impact of such a torrent of scientific information in the few thousand words of a column such as this. Instead, I'll focus only on a few of the new physics ideas, developments, and discoveries presented at the Atlanta APS Meeting that caught my fancy.

Super-Lasers—In the past few years laser physicists have made very rapid progress in increasing the power and shrinking the time-width of laser pulses. A prime example of increased power is the Petawatt Laser Project at the Lawrence Livermore National Laboratory in California, where physicists have been able to produce focused laser beams with intensities of up to 10^{20} watts per square centimeter. At that intensity a coherent light wave has an electric field of about 2×10^{13} volts per meter. Such huge electric fields propel atomic electrons to energies in excess of 100 million electron volts (MeV).

Livermore physicists directed this laser beam at a foil of gold backed by uranium and reported that nuclear gamma rays, neutrons, and positrons, as well as fission fragments, were detected after each laser shot. Thus, lasers of sufficient intensity can produce nuclear reactions. These are the first observations of (1) antimatter positron creation with lasers, (2) laser-induced fission, and (3) laser-produced electrons with energies above 100 MeV.

Another Livermore group directed a more modest tabletop laser with an intensity of "only" 10^{17} watts/cm^2 but with a time width of 3.5×10^{-14} seconds onto a jet of deuterium gas. The gas jet exploded, producing the fusion of some of the deuterium nuclei into helium-3, accompanied by an energetic neutron with a characteristic energy of 2.45 MeV. About 10,000 neutrons per laser shot were produced. This doesn't solve the problem of finding a practical way of extracting useful nuclear energy from deuterium fusion, but it could provide a fairly cheap tabletop generator of energetic neutrons.

This process is highly efficient, in that almost all of the laser energy is converted into ion kinetic energy. Therefore, let me speculate about its potential as a space drive. One can envision a laser-driven liquid deuterium engine in which deuterium is ejected as a propellant, with very efficient conversion of electrical energy to laser energy to ion kinetic energy, and with the added bonus of an energy boost from the nuclear fusion of a fraction of the fuel.

Complex Molecules from Space—Astronomers are coming to realize that some very interesting chemistry occurs

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in space, and that the chemical products may provide the precursors of life on planets such as ours. Diffuse interstellar bands were discovered in 1921 by Mary Lea Heger of California's Lick Observatory. She found broad absorption spectra in starlight that came not from the stars themselves but from some unknown medium through which the starlight was passing. Closer examination later showed that the diffuse interstellar bands had a complex structure that did not correspond to any of the known interstellar molecules (H_2, CO, CNO, NH_3, etc.) The origin of diffuse interstellar bands has remained a mystery for seven decades.

Now analytical work at NASA's Ames Laboratory has revealed the probable source of the diffuse interstellar bands to be polycyclic aromatic hydrocarbons or PAHs. These are flat "chicken-wire" molecules made of linked hexagonal benzene rings of carbon, with hydrogen atoms on their edges. The family of PAH molecules, with names like napthalene, pyrene, coronene, and chrysene, tend to be stable, colorful, fluorescent, and biochemically active. They are common in our environment; for example, they are a principal component of soot from a smoky fire. Recent studies suggest that they are among the most common molecules in the interstellar medium, with only H_2 and CO more abundant. Infrared and optical spectroscopy in the laboratory have now demonstrated a close match between the structure of diffuse interstellar bands and the absorption lines of the family of PAH molecules.

The scenario that emerges is that the young massive stars of the early universe produced carbon in stellar burning and then dispersed it into the interstellar medium in supernova explosions. This atomic carbon found its way to dust grains, where it accumulated. On this surface carbon and hydrogen could organize themselves into PAH molecules, then evaporate when heated. The result is that most stars, including our sun, are surrounded by a gas cloud including high concentrations of many PAH molecules.

With planet formation, these PAH molecules are captured. For example, fluorescence measurements indicate that asteroids in orbits beyond Neptune probably have surface concentrations of PAH compounds. On Earthlike planets with liquid water, the PAH molecules will accumulate in the oceans. The Ames scientists showed that shining ultraviolet light on PAH compounds can convert them into organic compounds that are present in henna, aloe, and St. John's wort. Thus, PAH compounds under the influence of sunlight can seed the oceans with complex organic molecules that are the precursors of the earliest biomolecules. It appears that a link in the chain that leads to planetary life has been discovered.

Atom Lasers and 4-Wave Atom Mixers—In previous columns I've described the atom laser (see *Analog* July 1997). While optical lasers produce light of a single wavelength with the waves all in phase, atom lasers produce a beam of atoms, all with exactly the same velocity and all the matter waves in phase (i.e., coherent). The first atom laser produced its atom beam as a spreading pulse, as the atoms of a Bose-Einstein condensate (see *Analog* March 1996) were simultaneously ejected from the trap that held them.

At the Atlanta APS Meeting Theodor Haensch of the Max Planck Institute for Quantum Optics in Munich described a new atom laser that produces a narrow and continuous beam of atoms, potentially with a beam radius as small as a nanometer (10^{-9} meters). Possible applications range from "writing" nano-scale structures with beams of atoms to ultra-precise measurements that test our present understanding of gravity and quantum mechanics.

Also in a previous column I discussed the 4-wave mixing technique in

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a non-linear optical crystal for producing a time-reversed light (see *Analog* June 1985). At the Atlanta APS Meeting Nobel Laureate William Phillips of the NIST Laboratory in Gaithersburg, MD described his investigation of non-linear effects with an atom laser, which produced a 4-wave mixer for atoms. The NIST researchers overlapped three Bose-Einstein condensates of sodium atoms moving in different directions as three beams which produced a fourth wave, while conserving energy and momentum.

Let me inject an idea here. In the NIST work the beams were *not* moving in opposite directions. However, if two of the beams are coherent and in opposite directions, the created fourth beam is the time reverse of the third beam, which is not required to be coherent. Thus, a modification of the NIST technique might be used to precisely reverse the velocities of a group of atoms forming a beam. Since the fourth beam is the time-reverse of the third, it will go back along precisely the same path taken by an incident beam of atoms. If these are gas atoms escaping from a confining vessel, the new beam will converge back to that vessel, retracing the path of the third beam. If the atoms of the third beam scattered on the way out, the atoms of the fourth beam will reverse this scattering on the way back in. This may offer a new way of testing the second law of thermodynamics (entropy always increases) in a new regime, exact time reversal, where it has not previously been investigated.

Direct CP Violation and the Matter/Antimatter Asymmetry—As discussed in my most recent previous column (see *Analog*, July/August 1999), it is now clear from astrophysical evidence that the universe is completely dominated by matter, even in very distant regions. There are far more electrons than positrons and far more protons than antiprotons in our universe. There is not the slightest hint of antimatter stars or galaxies.

This is a problem for particle physics because, at the particle level, energetic processes normally produce matter particles and antimatter particles (e.g., electrons and positrons, quarks and antiquarks, etc.) in pairs, so that the balance between matter and antimatter is preserved.

The only known exception to this is the so called "CP Violation" observed in the decay of "strange" K^0 mesons. Here the term CP violation means that if a given system were transformed by interchanging matter and antimatter (charge-exchange or "C") and by reversing the three space directions (parity or "P"), the resulting system is qualitatively changed. The universe as a whole is an example of CP violation because it contains more matter than antimatter.

The K^0 meson CP violation was discovered in 1962 by observing that K_{long} mesons, which normally decay into three pi mesons, were about two times in 1000 spontaneously transforming themselves into K_{short} mesons and decaying instead into two pi mesons.

A number of experiments have attempted to determine whether the K_{long} meson could also directly decay into two pi mesons without first being transformed into a K_{short}. This is of great interest because it distinguishes between possible explanations for the origins of the CP violation. The "superweak theory" which would invoke a new force to produce the CP violation, predicts that the K_{long} must always be transformed to a K_{short} before it could decay into two pi mesons. Quantum chromodynamics, the "standard model" of particle physics, predicts that about 4 times in 10,000,000 the K_{long} can decay directly to two pi mesons without prior conversion to a K_{short}.

At the Atlanta APS Meeting, the KTeV collaboration reported on their Fermilab experiment that observed the direct

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K_{long} decay to two pi mesons. This was a very difficult experiment because the quantity measured is so small. The group used two beams of K_{long} mesons, one of which was made to interact with a block of matter a short distance from their detector, so that K_{short} mesons were generated in the second beam.

By comparing decays of the two beams into two neutral pi mesons ($\pi^0+\pi^0$) and into two charged pi mesons ($\pi^+ + \pi^-$), they were able to extract the probability of direct decay.

Surprisingly, they observed that the direct decay occurs about 6 times in 10,000,000, considerably in excess of the normal predictions of the standard model. Therefore, the result falsifies the superweak theory, but it also pushes the standard model in a new direction, suggesting that the strange quark, present in K mesons, is less massive than has been previously estimated.

How is this related to the matter-antimatter asymmetry of the universe? We know that only about one extra matter particle in 100 million matter-antimatter particle pairs in the early universe would be needed to explain the present dominance of matter. The CP violation observed in these K meson experiments could produce this matter excess, but it is not strong enough to produce a matter asymmetry of the required size.

We must be missing something important. The only way of finding out what is missing is to explore the nature of the CP violation more thoroughly. The new direct CP violation measurement did this to some extent, and indeed produced a surprisingly large effect. The new "B-factories" that are about to come into operation in the next year can be depended upon to provide further insights into the nature of the matter-antimatter asymmetry and to add to our understanding of how the universe works.

There were many other new items of physics presented at the Atlanta APS Meeting which I don't have the space to discuss (including my own paper presented at the meeting). I hope, however, that the above may communicate some of the excitement, interest, and enthusiasm of this greatest gathering of the physics community.■

AV Columns On-line: Electronic reprints of 95 or so past "The Alternate View" columns by John G. Cramer from past issues of *Analog* are available at: *http://www.npl.washington.edu/av*. Additional information on the physics topics discussed above can also be found at the APS Physics News Update site at: *http://www.aip.org/physnews/update*

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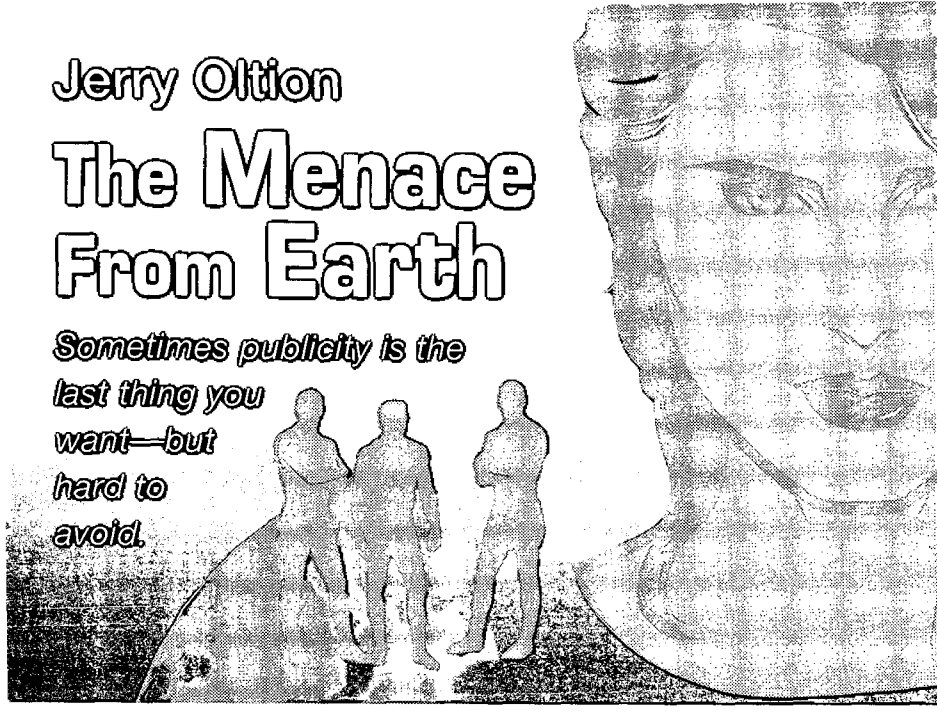
Jerry Oltion

The Menace From Earth

Sometimes publicity is the last thing you want—but hard to avoid.



We were exploring a sea cave on the west side of the island when the alarm went off. I felt it in the middle of my head, like a new center of consciousness blossoming into existence next to mine. I suppose that's exactly what it was, since I was little more than a projection myself. The mass eliminator that provided my quasi-corporeal existence had merely spliced the new signal into my data stream. Telepathy, of a sort. It was just one more in a long string of odd new abilities I'd acquired since becoming an astral astronaut.

The cave was only partially flooded. We stood on a rocky ledge maybe thirty feet in, at the point where the seaweed-draped cavern split; one branch reaching up into the headland and the other beneath the waves. I had been about to dive into the underwater passage to see how far it extended, but I paused with my hands outstretched and said, "Wait a sec. Incoming transmission."

"I feel it too," said Tilbey. He held the coil of rope I had planned to pull along behind me so Kylona and Etinitu—two of Islandia's lovely native women—could follow if there was anything on the other side worth diving to see.

Liam and Yavetra were back at camp. He didn't like caves, and she didn't want to come without him.

The feeling in my head grew more distinct, then an image formed as our starship's autopilot fed its long-range telescope signal directly into my mind. The dark cave wall, speckled with reflections from the sunlit waves beyond its mouth, became a field of stars against the backdrop of space. And in the center of it a fuzzy blue blob sported a pencil-thin line of white-hot flame. There was only one thing that could be: someone from Earth had followed us out here to Alpha Centauri.

"How far away are they?" I asked aloud. The autopilot filters my data flow for questions even if I just think them, but verbalizing makes it easier to separate them from idle thoughts.

"What?" said Kylona, following my gaze to the wall and seeing nothing there.

Illustration by Shirley Chan

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"Five light-minutes," said the autopilot, its synthetic voice flat and emotionless in my mind.

"*What?*" I did some quick mental math. "That's only . . . three hours flight time away."

"Who are you talking to?" Kylona asked me.

I blinked away the starfield and looked over at her, standing on the slippery rocks at the edge of the water without so much as a strand of seaweed for clothing. Tilbey's sweetie, Etinitu, stood beside her, equally nude and equally puzzled. I'd grown used to the sight of them; dark hair falling straight to their shoulders, skin tanned dark brown, bodies shaped by a lifetime of exercise and good nutrition—but now I saw them again as if for the first time. Technologically primitive, but intelligent, lovely—and loving. For a couple of milky-white dead guys from another planet, we were lucky they would even talk to us, much less care for us. After all, there were plenty of native men to choose from. I'd assumed they were mostly interested in us for the novelty, and I'd expected it to wear off any time, but they'd been our steady companions ever since we'd landed.

"The *Spook*'s autopilot," I told them. "It found another incoming ship."

"Oh." They knew what that meant. In the months since Tilbey, Liam, and I had arrived we had told them about Earth and UNASA and how the government's aerospace authority had tried to steal our experimental starship from us before we could leave. We knew UNASA would figure out the technology on their own and follow us here; we just hadn't expected them to arrive without warning.

Looking out the cave entrance toward the bright circle of ocean beyond, Tilbey said, "How did you let them get that close? Where have you been looking for the last month?"

The autopilot answered with the infinite patience of a non-self-aware program, "I have been monitoring Sol space continuously since ordered to do so. The drive flame started only two and a half minutes ago."

Tilbey looked at me. "The bastards coasted in. But if they just now lit the drive, they'll overshoot. Unless . . . how hard are they decelerating now?"

"One hundred and ten gravities."

He whistled softly. "I guess they've made a few improvements to the design."

Our ship, the *Spook*, could do fifty *g*s under full thrust, and that was only because we'd used Tilbey's mass eliminator to wring the inertia out of everything but the fuel. Even the passengers—us—had been Tilbey-ized. Unfortunately that meant we'd had to leave our corporeal bodies behind, so we existed only as "magnetically enhanced post-vivo standing waves," and our lack of substance meant we had trouble hanging on under heavy acceleration. If we weren't in containment fields when we lit the drive, we would fall right through the deck and out the back of the ship.

Presumably the same restrictions applied to the UNASA ship, but they apparently had a better stardrive and better containment fields for the crew. I wondered what other new and improved gadgets they had brought with them.

"I assume you've shown this to Liam," I said.

"He is getting the shuttle ready," the autopilot replied.

"Good. Tell him to come pick us up." I turned to Kylona and Etinitu, "We've got to go."

Kylona frowned. "To camp, or . . . ?"

"Orbit."

She looked stricken. "Will you be back?"

"We'll try," I said. "But I can't promise anything. We don't know what we'll be facing up there."

That wasn't entirely true. UNASA hadn't been happy about letting us slip from their grasp, so we figured they'd be carrying a grudge when they caught up

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with us. They probably hadn't come four light-years just to even the score for defying their court injunction, but that was no doubt part of their agenda.

We hadn't brought any weapons with us. UNASA never went anywhere without. The *Spook* would be a sitting duck for the first triggerhappy jetjock who wanted to take a shot at it, and when the ship blew, the mass eliminators that kept us alive would go with it. We would vanish like dreams, leaving Islandia wide open for Earth's worst representatives to plunder.

Somehow, we had to convince them not to shoot.

I gave Kylona a hug and a long kiss. "We'll do what we can. But if we don't come back, well . . ." What do you say at a moment like that? "It's been fun"? "I love you madly"? "I'm sorry we got you into this stupid mess, but if we hadn't we never would have met in the first place"? Nothing really covered what I was truly thinking, which was that it was a damn shame that paradise couldn't just go on being paradise.

She didn't like the situation any more than I did, but there wasn't much she could do about it, either. Her people didn't have space flight, nor even radio. If we didn't come back, they would never know what happened to us.

We knew what would happen to them, though. The odds that the UNASA crew would land on their particular island were vanishingly small, but eventually Earth would send real, live colonists, and within a century they would overrun the planet. Since we had made it possible for them to get here, we had to at least try to prevent it.

That was part of why we were still on Islandia. The other part stood there in front of us, looking worried and beautiful at the same time. We hadn't planned to end our explorations at the first planet we reached, but we hadn't expected to find it full of Amazon temptresses, either. This had to be the friendliest place in the galaxy. Even the men had welcomed us with open arms, which, considering how the women welcomed us, was probably the most amazing thing of all.

The Islandians had won Liam over completely. He had already decided to move his mass eliminator down from the *Spook* and stay here as the planet's guardian angel when Tilbey and I decided to go. He hadn't done it yet because we hadn't gotten around to building a separate power source for him, but we were working on it. I figured Tilbey and I would move on eventually, but neither of us were ready to break away just yet either.

Now I sort of wished we had. Liam had been a Marine before he'd been a ghost; he'd seen plenty of combat. I'd been born after the war and I didn't want to learn. And Tilbey . . . well, if you gave Tilbey a gun, you'd want to make sure he was on another planet before you gave him the batteries.

It was too late for second thoughts. A deep rumble echoed through the cave, much louder than the waves crashing on the rocks outside. "Liam's here," I said. "Come on." I took the rope from Tilbey and climbed over the wet stones to the cave's mouth, then angled up the rock face toward the flat ground a few dozen feet above the high tide line. Tilbey and I could have lowered our coupling constant—the degree with which our ghostly bodies interacted with real matter—and swum straight up through the cave's ceiling, but it wouldn't have been nice to leave Kylona and Etinitu to climb up the hard way. Besides, I hate sliding through solid matter. It feels creepy and it's easy to get disoriented.

We probably should have done it that way anyway. Tilbey got almost to the top before he slipped on a wet boulder and tumbled all the way back into the surf. Kylona and Etinitu and I watched as he bounced from rock to rock like a rag doll, yelling "Oof!" and "Dammit!" all the way down, then I threw him the rope and hauled him back up again. He

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wasn't injured, of course. We'd programmed our mass eliminators not to allow any permanent damage to our projected bodies. It would have been funny if the end of the world hadn't been drawing closer while he made his pratfall.

Our landing craft, a twenty-foot-tall egg on spindly legs, waited in a steaming patch of scorched ground atop the cliff. A couple of small bushes off to the side still crackled with open flame, so while Tilbey dusted himself off I went over and stomped them out. It hurt like hell, but it was no more dangerous than Tilbey's fall. Leaving black footprints on the bare rock, I limped back to the lander and climbed the ladder up one of the legs to the airlock. By the time I reached the top, my feet hardly tingled.

I suppose that invincibility is what had lulled us into leaving our mass eliminators in orbit. Now I felt even more vulnerable, knowing that real death was rushing toward us at a couple million miles per hour.

Liam had presumably said his goodbyes to Yavetra back at camp. I'd already said goodbye to Kylona in the cave. Tilbey took his time kissing Etinitu at the foot of the ladder, then climbed up after me. As I stepped into the airlock, Kylona waved and said, "Be careful." It was all very melodramatic, and I went on into the lander with a heavy heart, certain that we would never see our beautiful dark-haired lovers again.

So it was kind of an anticlimax when the radio came to life just after we'd lifted off and a friendly female voice said, "Hello! Anybody home down there?"

"Don't answer," said Liam, slapping Tilbey's hand away from the radio controls.

"Why not?" asked Tilbey.

"I want to get well away from here before I give them an easy way to track us."

That made sense. So we waited a few minutes while Liam flew us northward, ducking under as much cloud cover as he could find until we were a couple hundred miles away from our home island. We took the time to climb into our high-acceleration magnetic confinement cages and lower the coupling constant—and with it our simulated mass—so by the time we reached the middle of a large stretch of ocean we were ready for high boost. Liam said, "Hang onto your hats," as he took us up out of the atmosphere at thirty *g*s and headed for the *Spook*.

"Hello, calling Earth vessel," came the woman's voice again. "At least I assume you're the Earth ship. Yours is the only drive flame besides mine in the whole system. Can you hear me?"

Liam switched on the radio, using the holographic controls that let him interact with the ship even when he was nearly insubstantial. "We hear you. What do you want?"

"What do I want?" she asked, her voice full of surprise. "Good grief, I want to talk to somebody human! It's been months."

It had been years for us, but she had evidently boosted closer to lightspeed to take advantage of time dilation. She got no sympathy from Liam. "Nobody here but us ghosts," he told her.

She was silent a moment, then she said, "This isn't quite the welcome I was expecting."

"Sorry," Liam said. "Welcome to Alpha Centauri. Now go home."

"What's the matter with you?"

"What's the matter with us? I'll tell you what's the matter with us. We barely escaped the UN on Earth, and now you've come out here to harass us again. You're a bunch of thieves and cutthroats who think it's perfectly acceptable to 'appropriate' anything you want for the 'good of the people.' Well, you're not taking Alpha Centauri."

"Uh, Liam, should we be antagonizing them?" I whispered as soon as he let off the transmitter. "They've got the guns and the hundred-*g* drive."

"The best defense is a good offense,"

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he replied, and so saying he veered the lander around until we were aimed straight at the UNASA ship instead of the *Spook*. "If I can convince 'em I mean business, maybe they'll high-tail it before we have to ram 'em."

Tilbey looked wide-eyed. "Wait a minute. Nobody said anything about ramming anybody."

The woman replied, "You'd have a good point if I was from the Security Arm, but I'm not. I'm from Exploration. I came out here to see why you suddenly stopped transmitting after you got here, not to take anything from you."

Liam looked at Tilbey and me. We both shrugged. He turned on the radio again and said, "There's just one of you?"

"Yes."

"I wish I knew if I could trust you."

"Give me a chance," came the reply.

Liam took a second to adjust the reaction mass flow rate. Our engine was fairly simple; it just heated up a fluid and spat it out the back at high velocity. We used molten lead on the trip out, since it acted as shielding as well as a compact source of mass, but now we were using water. It was a little more finicky under high-*g* thrust, but we had a lot of it to play with.

I looked at the navigation display. Our two ships were headed straight for each other. The UNASA ship was still doing a good fraction of light speed, and we were building up to half a percent ourselves. A collision at this velocity would leave nothing but plasma.

Our ghost generators were on the *Spook*; if the magnetic pulse didn't overload them, we could conceivably survive it. The UN pilot couldn't, but she would never let us hit her. She had a hotter drive; she could dodge us easily.

Then I saw what Liam was doing with the fuel. "You're going to vent the tanks to space?"

"One of 'em," he said. "Just before we get there. That ought to create a cloud big enough to hit her even if she swings wide."

At the speed we would be moving by the time we reached the UN ship, even water vapor would hit like a brick wall.

"What do you say?" asked the UN pilot. "Can we at least meet and talk this over?"

"What would *you* say," Liam asked right back, "if I told you the planet's already inhabited?"

"It is? Great! What are they like?"

"I'm just asking a hypothetical question," he replied. "Assume they're bug-eyed monsters that drip slime and eat anything that moves. Would you tell Earth?"

"I don't know," she replied. "I'd look around first. Try to talk to them. Try to understand them before I decided anything."

"Hmm," said Liam. "Not a bad answer. OK, what if they're incredibly advanced beings with technology we've never even dreamed of. Would you tell Earth then?"

She thought about it a moment. "I still don't know. Maybe, maybe not. It's never pretty when a high-tech civilization meets a low-tech one. Especially if you're on the low end of the scale."

"Bingo," said Liam. "Final question. What would you do if the situation were reversed?"

She was quiet even longer, but when she came back on she said, "That's it, isn't it? You're afraid *we'll* destroy *them*."

"Just answer the question," said Liam. Our ships were closing fast.

She noticed it, too. "Hey, you're going to overshoot if you keep coming at that speed."

"Answer the question," Liam said. He held his finger over the holographic button that would vent the fuel tank.

She knew what we were doing. Knew she'd delayed too long to dodge. There was an edge of desperation in her voice as she said, "I don't know what I'd do. Are we talking Cortez and Montezuma, or Perry and Japan?"

"How about Cook and Hawaii?" he asked.

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"Who's Cook?"

"Wrong answer." His finger inched closer to the button.

"What, you want me to lie?" She started talking fast. "Look if there's a good reason to keep it secret, I'll keep it secret, all right? But I'll have to see for myself what's going on here and make up my own mind. I promise to be reasonable, but that's the best I can do."

Liam frowned, then pulled his hand away from the vent button. "You should know that we can still kill you any time we want to. It just would have been easiest this way."

He gave us a sideways nudge with the thrusters, and moments later our ships flashed past one other like laser beams.

It took a couple more hours for us to rendezvous in orbit around Islandia. The UNASA pilot, Ilex Smith, parked her ship in a polar orbit diametrically opposite the *Spook*, which gave her protection from any weapons we might have on board. It incidentally protected the *Spook* from her, so we didn't tell her she'd have been just as safe right next to it.

She let us pull alongside her ship in our lander and come across. She opened the airlock for us and Tilbey and I went inside, but Liam went through the wall beside it. "Could be a magnetic trap in there," he said.

There wasn't. We stepped out of the airlock no worse for wear, and a moment later Liam slid through the wall, accompanied by a flicker of lights as he accidentally shorted out the wiring.

"Watch that," said the ghost woman who hovered before us. "We're a long ways from repairs."

"Tell me about it," Liam said. The *Spook* was full of equipment we'd burned out by accidentally getting a little too intimate with it.

Ilex was just under six feet tall, slender, and shapely. Her white hair fell halfway down her back. I had to look close to realize she was a ghost; she had turned up her coupling constant to maximum so she could wear clothing, and she had chosen bright colors to offset the pale white of her face and hands.

"Excuse us for not dressing up," I said. We were naked as jaybirds, and had been since we'd died. It had never embarrassed me until now.

She didn't say much at first, just sized us up. Then she shook her head and said, "I hope you're not trying to impress me, 'cause if you are, I don't swing that way."

I don't know why it bothered me. I already had a girlfriend. If Ilex liked women, too, why should I care? Heck, Kylona and Etinitu and Yavetra sometimes got pretty cuddly with one another around the campfire at night, and if that didn't bother me then nothing should. But I found myself taken aback by Ilex's forwardness.

She was friendly enough. She gave us a tour of her entire ship, which was a marvel of efficiency. Ours was a modified cargo rocket, but hers was built from scratch for deep space. Small and sleek and packed with everything a person might need on a long trip away from civilization—it looked like my parents' motor home back in the days when you could fly them into national parks.

Tilbey was fascinated by her mass eliminator. It was a third the size of ours, and had its own nuclear generator. And it had a two-way interface that would let her transfer her mind back into a living body.

"You could grow a clone and get your body back," Tilbey said incredulously.

She nodded. "I could. Some of the rich people on Earth are doing that. Other ghosts just rent bodies when they need them."

We had stopped paying attention to Earth's radio broadcasts once we reached Alpha Centauri. Now I realized the place was liable to be unrecognizable by the time we got back.

There were two other mass elimina-

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tors on board. Liam worried that they were hiding more crewmembers in limbo, but Tilbey examined them and assured us they were just backups in case the first one failed.

Ilex hadn't brought a body along—even frozen, it wouldn't have survived a hundred *g*s of acceleration—but she had tissue samples and an artificial womb for growing a clone and a freezer to keep it in when she didn't need it. And of course she had backups of those, too.

She had a couple of weapons: a particle beam that could cook a ship from a million miles away, and a communications laser that could do the same job at ten times the distance. Neither one was powered up, nor had they been when she arrived in the system, if we could believe her computer log.

"Satisfied?" she said at last. "There's just me, I'm friendly, and I'm not hiding anything. Now when are you going to show me what *you're* hiding down below?"

We dithered a bit, but there didn't seem any reason to put it off. If we weren't going to show her, we should have killed her when we had the chance. So we climbed into the lander and headed back to the island we'd come to call home.

Kylona and her friends were overjoyed to see us again. They threw a feast even bigger than the one they'd thrown when we first arrived. The natives welcomed Ilex like an old friend, and she was delighted to find that some of them had learned English.

"I understand now why you're so protective of them," she told us that evening as we sat near the campfire and told stories about our travels. "If people on Earth knew this was here, they'd come running to put up condos."

"Or missions," I said.

She shivered. "I hadn't thought of the religious angle. You're right. There's no way missionaries could let people this happy live in peace."

"So you'll keep the secret?"

She thought about it for a while, then shook her head. "I don't know. It's hard to believe there's no way to keep these people safe without lying about them. And there's so many questions to ask! Like why are there people here at all?"

"We wondered that, too," I said. "They've got a legend about a big ship that brought them here from another island thousands of years ago, but we have no idea who it might have been."

Tilbey said, "It may be too late to hide Islandia from Earth anyway. We screwed up and sent a 'Nya-nya, look what we found' message before we realized the planet was inhabited, so they already know it's here. How much did you tell them on your way in?"

She shook her head. "I haven't even radioed that I've arrived yet. I had plenty of time to wonder why you went silent after you got here, so I decided to take a look around before I made my report. If I decide not to, they'll probably think I died in transit."

Liam tossed a knobby seed pod into the fire. "Or they'll think hostile natives killed us all and send a battleship next time. It would be better if you told them you got here and found nothing. Tell them we lied when we reported a habitable planet, and there's no sign of us now either. They'll think we did it to spite them and then took off for another star."

She watched sparks from the burning seeds rise into the night sky.

I said, "And if you give them a good video tour of the rest of the planetary system—minus Islandia—that might assuage their curiosity enough to keep them away for a while longer."

"We can hope," said Liam.

Ilex laughed. "Why do you think they sent just one person here? There are a lot of people willing to trade their bodies for a seat on a starship, but there aren't that many who are qualified for the job. The ships don't grow on trees, either. And there are millions of stars out

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there to explore. Billions. There's no way we could check out all of them in the next thousand years." She looked back down at Liam. "No, if I tell them there's nothing here, they won't come back any time soon."

"So, will you?"

"I don't know yet. I'm thinking about it."

The entire tribe had been listening in. Most of them didn't know enough English to understand what we were talking about, but they knew something serious was going on. Normally by this time of evening people would be pairing off and heading into the woods, but nobody moved, not even the men who had been trying earlier to win Ilex's attention. Then Kylona took her by the hands and said, "Come with me. I want to show you something."

"Okay."

They stood and disappeared into the darkness, firelight illuminating Kylona's bare backside and Ilex's colorful pants and shirt.

I didn't see either of them again that night. Their departure seemed to be the signal everyone else was waiting for; within half an hour I was alone by the campfire. I finally retired to the lander, figuring somebody ought to stand watch over our transportation just in case Ilex wasn't what she seemed to be, but nobody disturbed me. Nobody even came close to the lander. I know; I was awake all night, looking out into the darkness in case Kylona decided to return.

I didn't see much of them the next few days, either. I'd catch a glimpse of them now and then, running through the forest or swimming in the surf or playing volleyball on the beach. Ilex was easy to spot; she had shed her clothing that first night and never bothered to put it on again. A head taller than the other women and white as a snowbank, she stood out like a polar bear in a coal mine.

I could have joined them, I suppose, but I felt like a third leg. Unwanted, unneeded, awkward. I tried to tell myself that Kylona was just making sure Ilex really wanted to protect the planet, but it became harder and harder to remain convinced as the days went by. There wasn't anything I could do about it, though, so I kept my distance and let them have their fun.

They came to me once, to ask if I could teach Ilex how to fly. I'd tried it a couple of times when I'd first arrived, showing off for our new girlfriends, but it turned out to be more difficult than I'd expected. I looked worse than a penguin on land, so I hadn't done it much since, but apparently it had impressed Kylona more than I thought.

"It's highly overrated," I told Ilex when they asked. "You have to set your coupling constant to practically nothing in order to stay airborne, but then your arms don't do you any good when you try to push against the air."

"So I've noticed." She bounced a couple times on her toes, then said "Cee cee two percent" on the way up and continued into the air, windmilling her arms for balance. It didn't do much good, because she had become less substantial than a retinal afterimage.

"Try ten percent," I told her. "And flap like hell." I had to shout to make her hear me, since her eardrums were less efficient now, too.

She continued upward, just barely in control. I thought, perhaps uncharitably, that a good stiff breeze could solve my problem for a while, but I knew that Kylona wouldn't see it the way I did. She'd just make me chase Ilex down, and probably berate me for not warning her of the danger.

As it was, Ilex came down on her own—right on top of me. Kylona was laughing at her antics, and I was just beginning to grin, when she apparently got tired of playing the buffoon and returned her coupling constant to a hundred percent. Unfortunately I was standing right below her, with my own

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constant set to an energy-efficient seventy-five percent. I got a considerably more intimate view of her chest than I wanted, and when I pulled my head out of her rib cage and shoved her aside I saw that she had driven me waist-deep into the ground, too.

Both she and Kylona were laughing like fools now. I probably should have laughed too, but I *felt* like the fool, so I just clawed myself up out of the ground and stalked off with as much dignity as I could muster. They didn't follow me, and I didn't see them again for days.

Etinitu and Yavetra joined in the fun, so Tilbey and Liam suddenly had a lot of free time, too. We used the opportunity to do some long-overdue maintenance on the lander, then went up to the *Spook* and did more maintenance there. The starship was cold and airless, but it had been home during the long flight out from Earth and it could be home again any time we chose to use it. By the time we finished tuning things up it was ready to fly all the way to the galactic core if we wanted to take it there. With Ilex's permission Tilbey even loaded one of her spare mass-eliminators and clone tanks on board, then spent a few days in his lab figuring out how they worked and building another two sets so we would each have one.

Liam had to think about it a while when we asked him whether he wanted his mounted in the ship or taken down to the planet. The new mass-eliminators were self-contained; he no longer needed the *Spook*'s fusion plant for power. Ever since we'd discovered that Islandia was inhabited, he had intended to stay behind when Tilbey and I moved on, but now he wasn't so sure.

He finally fell back on his military training. "I don't like keeping all our eggs in one basket. Let's take mine down for now. We can always change our minds later."

I wondered how much later that would be. I actually felt a pang of regret when we left for the ground again. Considering how close Kylona and Ilex were when we'd come up here, I didn't imagine there was much left for me on Islandia by now anyway.

I was right, but not quite in the way I'd expected. Ilex and Kylona were both in space. They'd called down Ilex's lander on autopilot and ridden it back to her ship, where she was preparing a doctored report to send to Earth.

It was a wonder of misdirection. She took hours of video of every planet but Islandia, covering them and all their moons in such nit-picking detail that there was no question whether she could have missed a planet in the habitable zone. She even fabricated a landing site on one of the ice moons, which she said was evidence that we had refueled there before going on.

I met her and Kylona when they landed. She parked her sleek ground-to-orbit craft next to our bulbous cargo carrier, and a few minutes later the two women came down the ramp like royalty. No backing down a ladder for them.

It was mid-afternoon; the sun was bright on their glowing skin, and a light breeze wafted their hair out behind them as they came to the foot of the ramp. They were giggling like teenagers, sharing some private joke.

I forced a smile and said "Hello," and I gave Kylona a kiss, but my heart wasn't really in it. Especially when she made just a pretense of kissing back. I tried not to show my disappointment, but it must have been obvious.

"Thanks for helping us keep UNASA in the dark," I said to Ilex. I started to turn away, but she giggled and leaned forward to plant a big kiss square on my lips before I could react. It felt different coming from a ghost. She had her coupling constant turned up, so there was plenty of substance to it, but it wasn't quite the same as with a real person.

Something about it was familiar, though. Her lips were different, and she was taller—yet I knew that kiss.

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"Kylona?" I asked, incredulous.

Kylona, standing beside her, said, "Oooo, you win major boyfriend points for that!"

Ilex—at least her ghost body—said, "I told you he'd know the difference. Yes, it's me. We traded places. I wanted to find out what it was like to be a ghost."

"You . . . I . . . what?" I spluttered before I found my voice. Then I said, "Trade back! Right now!"

"But it's fun! You never told me how much fun it is."

When you become a ghost by falling into the machinery and electrocuting yourself, "fun" isn't the first word that comes to mind. It's not a word that comes to mind even after you've gotten used to the condition; it's just something that happened to you, something you learned to live with.

Kylona had chosen to do it, though, and she could go back any time she wanted to. Of course she would think it was fun.

"I want to fly," she said.

"No you don't. It's—"

"Cee cee ten percent," she said, and she became as insubstantial as smoke. Then she kicked off with her toes, flapped her arms, and rose up into the air.

"Come down!" I shouted. "You don't know how dangerous that is!"

"It's not dangerous. Look!" Her voice was thin and reedy now that her throat was no more solid than the rest of her. She flapped harder, rising up toward the tops of the trees.

"Stop!" I yelled. "The wind!"

But it was too late. The air was breezy down by the ground, but up at treetop level a steady wind was blowing inland from the ocean as the sun warmed the island. It caught her, whipped her right through the branches of a tree, then swirled her around and out of sight.

I turned to Kylona's body, which presumably housed Ilex's mind at the moment. "You!" I shouted. "She could blow halfway around the world before she figures out how to maneuver."

"Oh, relax," she said. "She's not in any danger. All she needs to do is raise the coupling constant again and she'll fall right back to the ground."

"Breaking her neck in the process!"

Ilex laughed. "She could hit the surface from orbit and not do herself any damage, and you know it."

That was true enough, but it didn't make me any happier. "And what if she hits at fifty percent?" I asked. I didn't wait for an answer, because we both knew what would happen: she would go right on through. While Ilex stood there thinking about it, I said, "Command" to engage the autopilot's control functions, then said, "coupling constant twenty percent," and leaped into the air.

I had to flap harder to stay aloft at twenty percent than she did at ten, but I had more interaction with matter so the wind picked me up even quicker than it did her. I swirled up over the treetops, spun around once in an eddy behind a tall snag, then bobbed along toward the mountaintop.

I could see her ahead of me, a tiny white cloud struggling to grab hold of passing treetops. Then the wind lifted her higher, and she tried to swim back down.

"Increase the coupling constant a little at a time!" I yelled, but my voice didn't carry much better than hers did. I flapped harder, trying to catch up.

I reached her just as she started to panic. I heard her scream, "Cee cee one hundred percent! *Two* hundred!"

"No!" I shouted, but it was too late. She didn't just drop; she streaked toward the ground like a rock thrown hard. Even at that she would have been okay if she hadn't reacted the way anyone would in a similar situation. I heard her yell, "Wait!" and then "Cee cee ten percent again!"

She faded to nearly nothing just as she hit the ground. The forest floor swallowed her up without so much as a *thud*.

"Command, coupling constant one

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hundred percent," I said, and braced myself for the fall.

I hit hard, jarring the simulated breath from my simulated lungs. I would have broken half a dozen simulated bones if my mass eliminator hadn't been programmed to avoid that unpleasant degree of realism. As it was I lay there for a second to gather my strength—and my courage—before I said, "Command, coupling constant ten percent."

The world grew dimmer as my retinae grew dramatically less efficient at gathering light. That didn't matter where I was going. I didn't need to breathe, but I took a deep breath anyway . . . and plunged down into the ground.

Swimming through rock isn't much different than swimming through water. You can feel it swish through your fingers, the various densities of stone and dirt and organic stuff interacting like the water at different depths in a pool, and when it gets in your ears and nose it's distracting as hell. I burrowed down a few dozen feet and began to swim in circles, calling out "Kylona! Kylona!" as best I could with a mouthful of granite.

I must have done that for half an hour without any luck. Of course by then I didn't know which way was up, so I wouldn't have been much help even if I had found her, but I didn't know what else to do. I was in full-blown panic and wasn't thinking very clearly, so I just kept searching. I probably would have kept it up for another hour or so, but I suddenly felt the hand of God yank me out of the ground, and a moment later I was staring at the inside of a magnetic confinement cage.

"Got him," said Liam.

I was inside the landing craft. So were Liam, Tilbey, and Ilex's body. "You found her!" I said. "Thank God you're safe!" I struggled free of the confinement cage, ordered my coupling constant up to normal again, and put my arms around her. "Don't you ever scare me like that again!" I said.

She cleared her throat and said, "I'm Ilex."

"Oh." I backed away. Then I gave her a crusty look and said, "Don't *you* ever scare me like that again either."

"Deal," she said. "Provided you make the same promise. We thought we'd lost you."

"I thought I'd lost *her*. What happened?"

"She popped out about a minute after she hit the ground. Found a tree root and followed it up. But when you didn't come up after her, we started to worry, so Tilbey brought the lander over and turned on the juice. He had to rewire it for a directional pull, but that took him about three seconds. He's *good*."

Tilbey shrugged. "It took five minutes, at least." The odor of burned insulation told me it hadn't been as simple as either of them made out.

"Uh huh," I said. I looked out the viewscreen. Kylona was outside with Etinitu and Yavetra, snuffling and wiping her eyes.

"Jeez, she doesn't know I'm safe yet," I said. "Excuse me, but I've got a reckless idiot to console." I went to push past Ilex, but she stopped me.

"Hang on a sec. I want to talk to you." She turned to Liam and Tilbey. "You guys go outside and tell her he's okay. We'll be right out."

They nodded and left through the airlock.

"Make it fast," I said.

"What are you going to say to her?" she asked me.

"I'm going to tell her what a damned fool she was, for one thing," I told her. "And then I—I guess I'm going to tell her goodbye."

"Why?"

I looked out the viewscreen as Liam and Tilbey approached the three women. I felt my heart nearly melt, but not quite. "I know where she's been the last few nights," I said. "And I know when I'm outclassed. I can't compete with you."

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She looked at me like I was some kind of bug. "I can't imagine what she sees in you," she said, "but the reason she wanted to trade bodies with me was so she could learn how it felt for you. And so she could decide if it was worth it to go along with you when you leave."

"Who said anything about leaving?" I asked.

"Apparently you did. Kylona thinks you might, at least, and she doesn't want to lose you when you go."

"Oh." I looked outside again. Kylona was nowhere in sight. I was just about to make my excuses and go find her when she burst in through the airlock and launched herself at me.

"Lover!" she said. I couldn't answer, my lips being somewhat occupied for a moment. She backed off just long enough to say "I'm sorry," then made sure I couldn't answer again.

"I'm going with you," she said a little bit later.

"How do you know I'm going anywhere?" I asked her.

"Because the trouble you've been waiting for has come and gone," she said. "I know you well enough to know what you'll want to do next. And I want to go with you."

"You'd have to die to do it!" I told her. "I won't let you do that."

She shook her head. "No I wouldn't. Ilex says I can freeze my body and wake it up again good as new whenever I want to."

I looked over at Ilex, who had been watching us, a wry grin on her face. She nodded and said, "She's right. The *Spook* doesn't accelerate hard enough to damage a body if it's frozen. Plus it won't use any air or food that way."

I had never even considered that possibility, but given Ilex's ability to move her mind back and forth, I realized it could work. I turned back to Kylona. "Even so, do you really want to leave Islandia behind, probably forever?"

She shrugged. "I want to see what's on the next island just as much as you do. If we come back later to tell tales, so much the better, but the journey is what matters. And being with you." Then she smiled wide. "Besides, I want to learn how to fly. Really *fly*."

"Well, I'll be damned." I glanced around at the inside of the landing craft. Hard metal and plastic everywhere. The *Spook* was more of the same. I hadn't really been looking forward to another couple of years on board, especially with just Tilbey for company. Suddenly the trip didn't look so sterile and cold after all.

At least not for me.

"What about Tilbey?" I asked. "Or more to the point, what about Etinitu?"

"She and Yavetra both want to go, too."

"Yavetra? But Liam doesn't want to leave Islandia."

She grinned at me. "That's what he thinks. If Yavetra goes, he'll go."

Six people on the *Spook*? It could get crowded. But it would be the right kind of crowd. Unless . . .

I looked back to Ilex. "Forget it," she said. "I know disaster when I see it. You guys will have enough trouble keeping from killing each other as it is, without adding a wildcard to the mix. Besides, I've got my own ship."

"Where will you take it when you decide to go?" I asked.

She gave a little shrug. "Who knows? It's a big galaxy."

That it was. I had no idea where we would go, either, but Kylona was right. The journey was what mattered. And who you journeyed with. ■

(Editor's Note: Earlier stories of the "Astral Astronauts" include "Kissing Cousins," [November 1998] and "Why Didn't You Think of That Before We Left?" [March 1998].)

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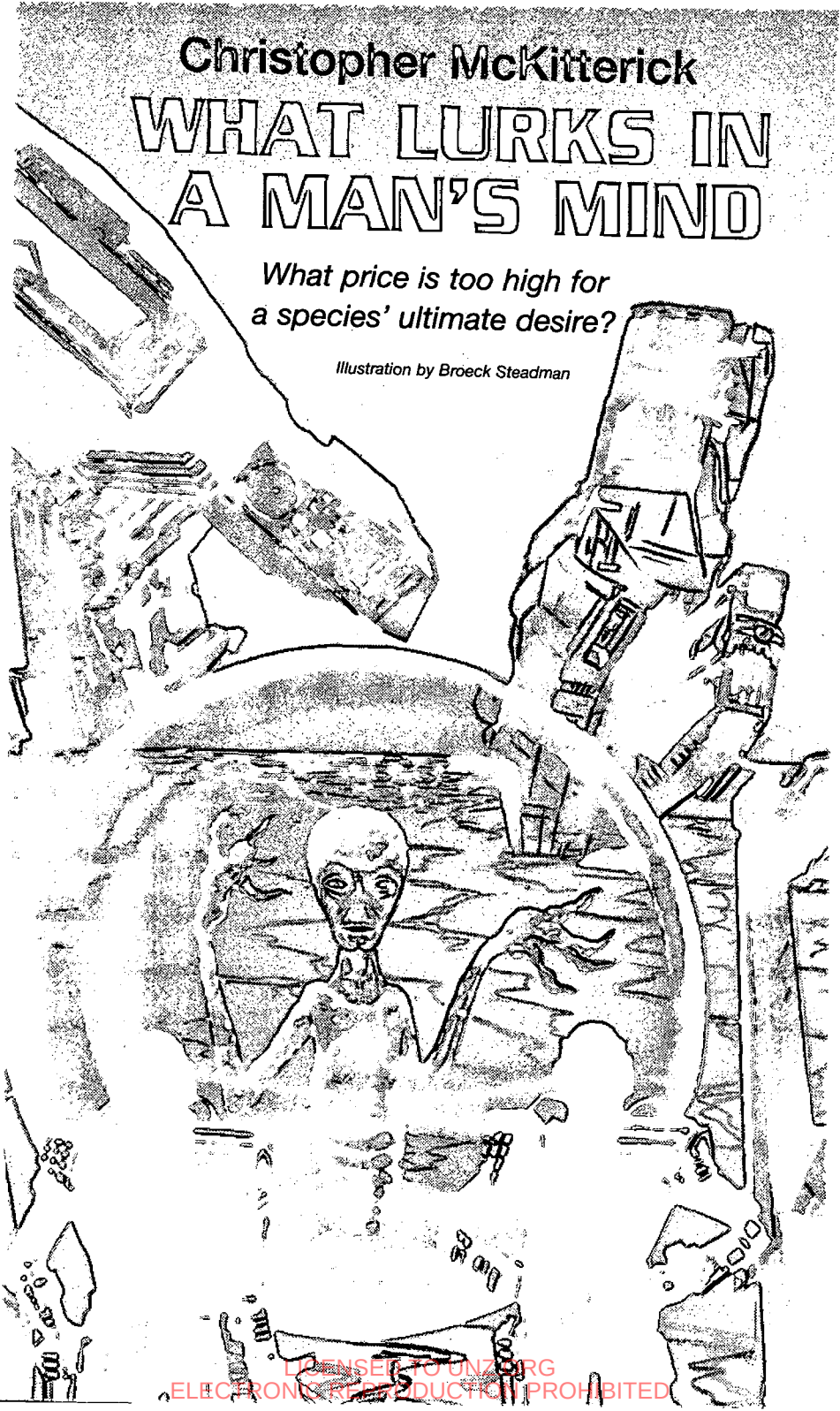
Christopher McKitterick

WHAT LURKS IN A MAN'S MIND

What price is too high for a species' ultimate desire?

Illustration by Broeck Steadman



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To conquer fear
is the beginning of wisdom.
—Bertrand Russell

I was assigned a rescue mission deep into unknown space. That simple assignment nearly destroyed the human race.

The Alliance sent Marines instead of ambassadors—a seemingly sensible gesture since the galaxy's been in various states of war for two centuries. We turned out to be the exact wrong people for the original mission, yet the exact right people for what the mission became.

My boat fell into normal space at the coordinates where the *Halifax*, an ill-fated interstellar survey vessel, had reported discovering a camouflaged world. Alliance brass assumed the survey craft had stumbled upon a pirate stronghold and been captured; that's what such disappearances usually meant.

Ryon 312-D—the planet's interim designation—was visible only because of what was *invisible*. As the boat slowed to orbital velocity, swooping around an orb of darkness, background stars melted from sight aft and new ones appeared fore. Guidance told us we were sixty-eight kilometers above the surface of something, and the gravgauge told us that something massed .71*E*.

I gave the order to engage the descent program. We were to duplicate the missing vessel's every move, though with a bit more confidence: The *Yantic* was not a fragile survey craft, but an older JT2-Mk.1 armored Marine transport with room for the nine of us and a dozen more, in case we found survivors. What's more, the old bird had been retrofitted based on the *Halifax*'s final reports; they had been scientists until the end, detailing the loss of their vessel.

At thirty-one kilometers, we came up against a barrier that acted like a balloon around the world, repelling and deflecting the boat without damage. Ship's computers studied the phenomenon, telling us nothing useful except that we had lost twenty-one percent power while in contact with the barrier.

"Maybe it's some kind of huge energy field," my pilot, Movi, suggested. I didn't care *what* it was, I just wanted through it.

"Coleman," I called to my gunner, "go to plan B."

He smiled, nodded inside his helmet, and turned to his control panel. The railgun belowdecks thumped and made the deck shudder. Then the systems began to fail.

My soldiers reported loss of power to weapons, then main drive, then secondary systems. We fell into the gravity well. This time the barrier only slowed our descent as artificial night swallowed us. My mind sharpened, knowing our real work was getting close: we'd soon be down among the hostiles, something more familiar to a Marine than sitting helpless in zero-*g*.

At seventeen kilometers above the still-invisible surface, the *Halifax*'s final reported altitude, we lost communications. Our suit telltales blinked off, the combat and nav computers forgot what they were thinking, and the vessel's countless screens and indicators faded to pale LCDs and blank holopanels. Winds buffeted the hull.

"All systems down, Captain," Movi said. Her voice was muffled by her helmet, but our suits were designed so we could communicate in close quarters without power. "Redundant systems aren't engaging. Even the backup computers have gone to sleep." She lifted her hands from the controls, looked at me, and shrugged.

"Fire the chemical rocket," I ordered. She nodded and reached for the ignition lever bolted crudely over a hole torched in the deck.

The crew was a standard mix of jarheads; "expendable" must have been the official designation on some Alliance database. Before Movi pulled the lever, I

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sensed sweat and silence, heard only the wind and the wheeze of anxious breath through my Marines' respirators. The suits were old tech, but I'd picked them since they could operate without power: Just inhale hard and you get air, just urinate and a bag beside your leg collects the warm stuff.

The rocket blazed to life beneath us. Ha! I thought. Bet you didn't expect ancient-tech backup, eh? To hell with you pirate bastards. But the laughs were on me: A few seconds later, the rocket flamed out. Movi didn't need to say anything. I'm glad she didn't; I would have bitten off her head. How in hell could they shut down a chemical reaction? There's nothing like fear of the unknown to piss off a Marine.

Then the dark shroud around the boat vanished, and a watery world appeared through the ports.

My crew of eight Marines' breath heaved as one—slow, deep and hollow in their suits while we freefell toward a world whose homogeneous dark blue was broken only by paler shallows and occasional green blemishes. We were 104 light-years from the nearest Kosmos Marines' base, we had no power, and the rocket that the brains in Engineering installed had only burned for a tiny fraction of the time it was guaranteed to run.

I heard the crew's breath stop for a moment, waiting, perhaps, as I was for Death to crash through the hull, fire and bones, perhaps riding a horse with skin made of interwoven energy beams, as in the nightmare I had so often, the dream that made me harder inside every time instead of scared. Alliance brass had expected anything and had armored the boat against all but the heaviest weapons. But nothing violent happened, at least not for a time much longer than a human can hold his breath.

During that long silence, Movi couldn't restart the rocket. She finally turned a blank face toward me, shaking her head inside her helmet. I nodded, acting confident that everything was unfolding exactly as expected.

We were soon gripped in a forcefield the *Halifax* hadn't been able to report. I felt a sort of chill . . . we were up against planetary defenses of a kind I'd never before seen.

It seemed as if a vast, gentle fist dragged us across the sky. The boat continued to fall—though I was certain something was causing us to decelerate—at a steep angle toward the endless sea. Approximately ten kilometers above that ocean, I ordered the crew to brace for impact, knowing the precautions the engineers had taken at Base Station would have little effect if we hit at too high a velocity.

"*Captain*—" called Davis. He didn't need to elaborate. Staring out the fore port as ocean rapidly grew to encompass the entire view, we could make out artificial shapes in the water. At about five kilometers, they resolved into spaceships' hulls, split and discolored, strewn amid rocks as if this place had seen a great battle. Oddly, I could only see one area of concentrated ship graveyard, while the rest of the water was clear and uncluttered; this spot appeared to be the outlet of an invisible funnel from space.

At a thousand meters and falling, I don't imagine my crew paid much attention to anything but how well their crash-webbing would hold.

"Prepare for hardland," I ordered, then we hit the water.

Impact was milder than I'd feared, even though we'd been decelerating. I guessed the rocket had done its job. During the downtime we'd spent en route to Ryon-D, I'd imagined a thousand different endings to a meteoric descent, all of which entailed mutilation and destruction. What actually happened is that we struck the ocean's surface—crash-bubbles inflating via compressed air—then continued down like a spear thrown at a fish until we hit bottom.

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The sea was unexpectedly shallow, perhaps a hundred meters deep, the floor carpeted with a sort of mossy growth that transformed into black clouds as we tore through into the sand beneath. I got a brief glimpse of what looked like the ruins of a sunken city, but, whatever it was, it was buried in drowned space vessels. A sick grinding rang through the *Yantic* as the hull scoured against the sand, rebounded, and then the boat floated to the surface and began to bob, gently. Our crash bubbles deflated. However, if the leaks were any indication, the *Yantic* had taken the hit harder than we had.

"Marines!" I shouted, disentangling myself from the webbing, "check your suits and prepare for aquatic combat. Keep your arms on safety. Prepare to repel boarders.

"Movi! Take B-squad and secure all leaks. Get me a damage report now!

"Coleman! Check the arms locker and make sure everyone has working gear.

"Hakim and Davis! Drop something for an anchor. I want this boat upright and stable.

"Malkov and the rest of A-squad! Prepare the water raft and get our gear ready to go out there and find the enemy. All of you, move, now!"

While my soldiers rushed to their business, brushing against one another in the cramped confines of the vessel, I peered through the fore and aft ports, starved for tactical data. All I could see were those derelicts as we floated on the waves, half submerging as crests washed over our hull. The ships protruding above the surface were vast, all larger than a *Monte Carlo* class cruiser, some bigger than a Chaos-Times dreadnought. They'd *have* to be big in order to rest on the bottom and rise into the sky like metal islands, volcanoes, rotting fists. One mountain of a ship was so ancient it looked like little more than a rusty skeleton. Birdlike things roosted in its joints. We might be leaking, but we were better off than the other ships.

Maybe forty vessels broke the swells, a few alternately disappearing and reappearing as waves passed over their sunken hulls. Who knows how many more were buried at sea, too small or too rusted to be seen. All stood in various stages of damage and decomposition, some crinkled lengthwise and split open at every seam, others torn and folded into origami shapes, still others barely ruined but enamelled with centuries of organisms and rot. And not a one recognizable as belonging to the Kosmos Marines. A few looked like the types of craft fielded in the Chaos Times, but most looked like nothing I'd ever seen, and I've become pretty familiar with warships during seventeen years of service.

Also sprinkled among that graveyard were rocks, big rocks. Not islands, no; they were too uniform. They looked like asteroids, perhaps fired in anger at this world. One, which rose at least fifty meters above sea-level right beside where we floated, was so big that I saw the curve of its underside before the waves hid it, like a god's ball set near the wrecked ships, like a tombstone. If we had hit that instead. . . .

"Captain!" Hakim said. "Look!"

A small, alien figure approached. When I say that, I don't mean it was riding in a raft or anything. It simply floated toward us on air, walking on water without even moving its feet. As it approached, I could resolve a simple torso, somewhat round, about the size of a human child's; head and neck much like a human's in proportion to body but hairless; no shoulders, but two long and spindly arms ended in what looked more like lace handkerchiefs than hands; two short legs ended in stubby flippers. When it stopped, about ten meters from where we bobbed on gentle swells, it settled into what might have been a seated position and closed its two great eyes. I couldn't make out any genitals or mammaries, any ears or nose, and couldn't even see its thin

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mouth at that moment; its skin was completely smooth, dark brown with a blue tint. I applied the sex of female to it, out of habit and since she just sort of . . . I don't know, *seemed* more female than male.

It appeared that we weren't dealing with pirates, after all. The mission was getting more and more interesting all the time. I hoped we would survive this, if only because a first encounter with a new species can make an officer's career.

"What now, Captain?" Malkov asked.

"A-squad, we're going outside to say hello," I said. "We have a first-contact here, so hold your fire unless fired upon."

I tried to ignore the *Yantic*'s condition and concentrated on our primary objectives, rescuing the lost explorers and finding out why the locals had wrecked the *Halifax* and stranded us. Did they have their eyes on human holdings in nearby space? Could we establish peaceful dialogue and trade? I assumed this floating creature was an example of the dominant, native lifeform—a Ryonian, I decided to call her.

"We have to try to communicate with this . . . Ryonian," I said. Silently, I damned the otherwise-thorough planners for not including a xenolinguist in my crew. I assigned B-squad to remain with Movi and repair the boat while ordering the four others to exit with me.

When we cranked open the outer hatch, the lock flooded with water; Mk.1 transports have their locks underdecks, so we emerged several meters underwater. After some awkward maneuvering in our heavy suits, we shoved out the rubber raft and gripped its handrail as one of the squad activated the raft's inflators. It buoyed us up along the dented armor of the *Yantic* to the surface.

Two soldiers rowed as another steered us toward the alien; A-squad leader, Coleman, sat at ready, chemical pistol in hand. I noticed a haziness, about ten meters in diameter, enclosing the Ryonian, as if she were suspended within a bubble.

We didn't threaten the creature in any way, but as soon as we got near the bubble, we all were slugged with blinding headaches that blotted out vision and sent our thoughts down the way of dreams. I imagined I was talking to someone, only I had no idea what I was saying or to whom. I felt alternately that I was back at primary school, then the university, then the academy and suit camp, working on school lessons and practicing combat. Soon I went to war again, fighting crazy rebels and pirates.

Based on how far we'd drifted, the headache and dreams couldn't have lasted more than a minute; still, it felt as if days or years had passed. When my mind was mine again, I surveyed the squad sprawled about the raft, gripping their helmets as if they could massage their throbbing skulls through the shatterproof plastic and carbonate armor.

Before I could react, Coleman raised his pistol and fired at the alien. Belatedly, I tore the weapon away from him.

But the tiny rocket had exited the barrel in a puff of exhaust. It screamed toward the alien only a few meters away, then began to slow instead of accelerate. Its tiny motor flared in place for several seconds before burning out, and the projectile fell harmlessly into the rolling waters. I turned to Coleman.

"Vacuum-head!" I shouted. "What were you thinking? Never act except on your superior's orders. This is not a battle situation. Take an oar from Kaplan, now!"

Just as he and the other Marine stood to swap places, an invisible hand ripped the pistol from my grip, hurled it thirty meters through the air, and slammed it against the fallen asteroid.

Then Coleman grabbed his chest and began yanking at his suit's tubes and switches. He opened his life-support casing and seized the oxygen regulator.

"Coleman, cut that crap out!" I shout-

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ed, my voice suspended on the thin edge between anger and fear. I automatically reached for the dangling hoses, but he was disconnecting them faster than I could reattach them.

"You fool! What're you doing?"

In a spasm, he twisted toward me, his face a blue mask, eyes bulging, lips pressed inward, nostrils compressed, blood popping in droplets against the faceplate. That sort of thing only happens in extremely hostile environments, not on gentle worlds like Ryon-D. I reached for him, but his body was yanked from my grasp and slammed into the water so hard that his helmet shattered and his body armor blasted across the surface for several meters before sinking. He vanished beneath the waves at the base of the great, round tombstone. It would have been futile to send a rescue team down after him.

"Captain," someone said. The voice sounded awfully clear without a helmet mic. "You will leave soon."

"Who is that?" I shouted. Things had gotten out of control, and I was beginning to have trouble reasoning.

"Since you name things, call me Sacra," the speaker said. "It was I who said you will leave."

Something about the sound of the voice made me look at the Ryonian. "You," I said, pointing at the little creature squatting just centimeters above the water, wavepeaks splashing her folded flippers. She raised both long arms above her head, lacy hands fluttering.

"I."

"Captain . . . ?" one of the soldiers began. I blinked.

"How'd you learn to speak my language?" I asked.

"From you," Sacra said.

From me? "When did I teach you anything?" There followed a long pause. A hundred meters behind her, a bird-thing swooped down to the water from a wrecked vessel and returned with a fish in its beak.

"You are quite primitive," Sacra said.

That kind of comment usually pisses off a Marine—we may be grunts, but we're also educated, state-of-the-art, unlike the soft half of our Citizens—yet I'd had specific instructions on how to deal with intelligent aliens. The brass had long ago decided to make treaties with superior races and then leave them alone.

"As soon as you entered my personal sphere," she said, "you began to share with me what you know. I severed the connection before I was severely injured. It is psychologically damaging and physically painful to learn the ways of your kind, so I have decided you must leave. I cannot allow anyone else's sphere to touch you, especially not that of the larvae, and you are near them. I must take you away."

"Wait," I said. "We're on a mission. We came a long way to rescue—"

"Those you seek are not here. Tell your companions to evacuate your spacecraft and join you. I have decided—"

"*Wait!*" I said, balancing between violent anger at her attack and the kind of patience officers are taught to use when confronting new alien species. "Notify your authorities that we need to speak to someone in command."

"I am the closest to what you consider 'authority,'" Sacra stated. I clenched my jaw a few times, considering. No leader would enter a dangerous situation without a division of guards, right?

"I don't believe you," I said.

"We have no unbalanced government such as you burden yourselves with," she said. "We have lived satisfying lives for . . . seventeen thousand of your years with no governments such as you serve, such as have nearly destroyed your civilizations. But I am the protector. I, alone among those still on my world, bear personality-scars from encounters with dangerous beings like you. For twelve of your centuries, I have been a protector, and they have been lonely years. Intruders are my only company, and a peaceful

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intruder is as rare as a supernova. Supernovas are the pinnacle of violence, yet they are the ultimate force of creation. You see my position."

She stopped speaking and turned her face upward, toward the small, hot disk of the sun sinking in a bleached sky toward the ocean. Then she looked back at us, her deep eyes absorbing mine.

"There will be no more discussion. I cannot permit you to come into contact with the others and infect their minds."

My face burned, my fists hardened, my back tightened—especially on the left side where a fused bulkhead had slammed me long ago, during combat with a Marine ship stolen by pirates. I relived that fight again, only for a moment, but long enough to realize my damned mind had gotten raw, loosened since our encounter with Sacra. That little Ryonian had decided we were to leave before we even had a chance to accomplish our objectives. And after wrecking my boat and killing Coleman. Granted, Coleman had fired first, but I'm responsible for my crew, even for hot-headed fools like Coleman. You can't ignore something like that, even if you command different crews each mission.

"And if I refuse?" I asked, keeping in mind the power she held over us. Waves splashed beneath the raft and wind howled through the great wrecks. I made no sudden moves.

"You have no choice."

I realized it would be fruitless to argue further. Could Sacra be threatened with violence? No. Coleman attested to that. Surely, she could defend herself against our personal weapons with that protective field. Could she kill us if we attacked hand-to-hand? It drove me crazy that I could be so easily manipulated by such a slight creature, to be surrounded by power which I couldn't lay my hands on or even understand; where was it, underwater? And how did she control it, telepathically?

I glanced at the spaceship graveyard around us; the Ryonians possessed the capability to bring down craft as big as our heaviest dreadnoughts. So much I needed to learn: How did their control fields operate? What was the energy source? Where was the *Halifax* and its crew? Whose wrecks were these? How long had they been there? Did they belong to the races that were now covertly invading the edges of Alliance space?

"Where can we find the ship of ours that crashed here 220 days ago?"

"The vessel is one kilometer southwest," she said. "The crew is gone."

"What—"

"Do not ask any more questions," Sacra interrupted. "I am severing communication with you."

"Not just yet," I said.

I thought it would be to our advantage to play a wild card. Because she had revealed what kind of danger we were to her people, I realized the Ryonians *could* be threatened, if not with violence, then with something more dangerous. It came to me all of a sudden, a flash of insight, an islet of rationality jutting out of a sea of fury. Power *over*, not overpowered. I smiled as I prepared to play the game. I saw it as the only way to accomplish our mission, and I always completed my missions. My bluff assumed she had no way to read our minds without our knowing it; that is, without feeling a whopping headache. I also had to hope the parts of my mind she had picked through didn't contain information that would work against me.

"If it's so burning important that you get us off your world," I said, "how would you feel if I said that hundreds more ships will be arriving soon unless you cooperate? I'm sure you could kill any of us with a wish, the way you killed Coleman, but could you handle hundreds of ships and thousands of soldiers at once? And even if you could, wouldn't our minds contaminate the rest of your people? How does that compare to a few Marines looking for a few stranded civilian explorers?"

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Sacra didn't answer immediately, but it was obvious she had heard. I was suddenly aware of the air's pungent, briny scent. Sacra's eyes stared unblinkingly at me, great black orbs embedded in a round face. Then her lips parted slightly, revealing a slit just beneath the eyes. Sacra spoke from that mouth now.

"That is sad," she said with an accent strangely reminiscent of an old instructor's, "and it is a lie. But it is also more true than you believe. I had hoped I misunderstood your psychology. There is nothing more important to me in my role as sentinel than keeping my people from contact with races like yours.

"Long ago, we were much like you: aggressive, hungry, violent. Now they are peaceful and content. I am what you would call a pervert, an evolutionary throwback, else I would be unable to perform my . . . unfortunate duties while remaining functionally sane. But I have grown weary of communicating with you. Your race is more ill than any I have encountered before. We must leave. I have a mission of my own to complete now."

The words wavered, like a sob. But who can guess the emotion of an alien? Still, her speech created an ache inside me, opened up a wound where I had never thought to armor myself: in my heart. Maybe it was just more of her telepathy, or maybe it was that my own emotions were raw after she had torn them open.

"Listen," I said. "All you need to do is lead us to the people we're looking for and we'll lift off. Well, as soon as we repair our boat. We'll leave you alone, and the fleet will have no reason to invade. You won't have to worry about us if you just lead us to our comrades."

My answer came not in words but in action: the *Yantic* split open, stem to stern, and the four Marines inside floated up and out of the sinking, bubbling hulk like cats lifted by the scruffs of their necks. We aboard the raft, too, were lifted into the air, something firm yet invisible pressing against the soles of my boots. When I looked down, I noticed that the bubble which encompassed Sacra had grown to surround us as well, so that we stood on its inner surface. If I had to guess, I'd say it was the same sort of thing that the *Yantic* had rebounded against in the upper atmosphere.

"We leave now," said Sacra, and so we did.

A momentary sense of dizziness swept through me, and when I regained full awareness, we floated a meter above the weed-choked terrain of a planet lit by an orange sun. Instantaneous interstellar travel. . . . I stood in silent awe of her race's power and found it impossible to imagine what it would be like to engage her kind in combat. Then Sacra's personal sphere shrank, and we eight humans fell to the ground.

"This is an uninhabited world outside of what you call Alliance space. You can survive here, but you will not be able to tell your people what you've learned. I leave now."

"Wait!" I shouted, angry and confused. I had threatened her with what seemed to be the worst evil she could imagine, yet her response was to bring us to a habitable world rather than permanently silence us. I couldn't accept her treating me with honor when I had treated her with disrespect.

"I want to let you know that my threat wasn't real," I said. "I don't have the power to order such an attack. Let your people know that I won't recommend it, either; in fact, I'll tell my superiors to leave your world alone. You won't have to worry about us."

"Perhaps . . ." Sacra said with her mouth. Something about how she said it gave me hope. Then she looked at the sky again, an alien sky and an alien, orange sun, and I wondered what she saw. I heard muted thunder.

She said, "Ah, but it does not matter, Captain." Her words fell quiet, soft, like delicate living things fluttering from her

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lips. Each word aroused a great sadness within me. It was as if I could feel her emotions as she spoke. Which, I guess, might have been so.

"The first scenario you described will eventually come to pass," she said. "Your tenacity and sheer numbers will make it impossible for us to avoid learning your warlike ways. My people cannot bear to live through another age of wars as we once did. We sentinels, alone among all the living, remember that time. My people barely survived our internal strife. We exterminated whole species, sterilized planets. And now . . .

"The other old sentinels like me are . . . away on duty. I cannot permit the wars to return, so now I have a duty, as well. This is a sad day, a very sad day."

Then her eyes closed and she was about to do something—*what?* Were we to die, right here, far from our families, where they could never mourn us? I felt my heart throb, imagining it was about to burst. What had I done? I sensed that we stood on the cleft of some grand change, some nightmare I had brought about, and I had to stop it. My skull throbbed so that I imagined it was about to crack open and spill my brains into my suit. I felt a thousand ills at once, each one a death to silence me forever about the Ryonians.

But suddenly, my upset gave way to terror as her emotions spilled over into my mind and I understood that the terror I felt was hers. Whether this mental communication was intentional or driven by the depths of her sorrow, I couldn't tell.

No, my crew and I were not to die. It would not matter if we were silenced, killed. Sacra had recognized my threatening words as truer than I imagined: If we did not return with the crew of the *Halifax*, more Marines would be dispatched to find out why. And the next missions wouldn't arrive in piddly-ass armored transports; no, they'd show up around Ryon-D in state-of the-art destroyers, dreadnoughts, and eventually planet-busters bearing tens of thousands of fighting men and women. Surely those ships—or most of them; I had no idea how powerful the Ryonians' fields could be—would be torn from the sky and swamped in the sea. But there would be survivors.

She recognized, through me, that the missions would never cease, and soon warriors would swarm across the surface of Ryon D. . . . It wouldn't matter if our weapons were impotent, for our true weapons lurked within our skulls. What petrified Sacra was that the Ryonians would learn the qualities that go into developing a lifer-Marine. They would learn the pitiless, amoral resolve necessary to execute a combat mission; they would learn the motives for war, the *why*. They would learn what it takes to kill a person or a ship full of them without allowing it to haunt you throughout your life. They would learn . . . well, the *thrill* of crashing through death and coming out on the other side, of killing and not getting killed, of emerging from a glowing cloud of shattered battleships in one piece.

In short, they would relearn everything they were hiding from, what had once made them monsters.

She had learned enough by absorbing data from my mind that it would happen regardless of whether my crew and I survived. And letting my crew return would be just as bad for the Ryonians' isolation.

The terror was not mine, I knew: I feared not for myself, nor for my crew; a Marine is always prepared to die, from the moment he or she steps out of suit camp until an enemy vessel bears down, cannon blazing, missiles launched like ambassadors of death. And a captain must be prepared to watch his crew perish in combat—else what good is he?

I certainly didn't worry about the additional scar we'd inflicted on Sacra by our mere presence; that was just the price she paid in her duty, just as death is a Marine's price. Nor, I must admit, did I care that we threatened to damage her people's minds.

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Those things were all terrible enough, I guess. But the terror she shared with me ran deeper. What was it?

"Sacra," I said, ignoring the telepathy headache, "why are you so scared?"

The thunder was growing closer. I felt a chill breeze.

"You humans view any alien power as a threat, even—or perhaps especially—other human powers. So, too, was it for us during our violent times. But we had no aversion to xenocide." Fury poured out of her now, and the rest of my crew fell into the weeds, clutching their helmets.

"Do you know what my duty is when I find races such as yours? I have avoided it whenever possible, disposing of scouts and explorers so their people would not learn of us. But that is only a stalling tactic.

"Captain," she said, floating nearer me, hands fluttering fast, "it is now my duty to locate each and every cell of humanity by stripping your minds of information, and then to scour worlds clean of your presence just as you scour space vessels clean of alien viruses and bacteria after planetary duty." She closed her eyes and floated several paces away.

I stumbled back, trying to think. If what she'd said was true. . . . There is *nothing we could do to stop a force* which can turn our best weapons and fighting ships into mere collections of junk, which can make our bodies revolt violently from within.

A small voice in my head said, "Do you understand my feelings now? I . . . must . . . go." The last she said so slowly and with such a burden of hopelessness that I could hardly speak.

"Sacra," I shouted, panicking, "listen to me." She opened her eyes and stared into mine.

"What is it?" she spoke, quietly, using her mouth.

"We must save both our races from the nightmare you describe. You're more ethical than this so-called duty; I mean, you try to hide your world, you land invaders without harm, you move intruders like us to where we can't talk to our people. Everything you do minimizes the murder you must commit. I ask: Do you really enjoy murdering entire races?"

It was as if a ship slammed into my chest, hurling me to the dirt. I felt a surge of hatred and grief stronger than any before; now I recognized these emotions as not my own. When my sight cleared, I stood, undaunted by her power, awaiting her reply.

"No, Captain," she said, "I loathe my duty."

"Then," I said, playing a new hand that could doom the entire galaxy, "you are not the throwback you think you are, after all, are you? I know your race's powers seem godlike compared to ours, yet at the same time your people's morality seems no better than a dangerous child's." My Marines stared at me in disbelief. Sacra revealed no reaction and projected no emotions. At least she was listening. I hurried on with my explanation.

"Who is the real danger? You, yourself, said you cannot permit your people to associate with aliens because you will return to a barbaric state. So your race is only better than ours through ignorance.

"The era of peace is over for your people, Sacra," I stated, pointing at the sky. "The barbarians of the galaxy are growing up and taking to the space lanes. Tens of billions of humans live on thousands of worlds across the galactic arm, and it's only a matter of years before your region of space will teem with our vessels, then the next species', then the next. A few thousand years, and the galaxy will be crowded with intelligent, spacefaring races. You cannot remain isolated for long." Now I pointed at her, the anger I felt my own.

"Can you stomach that level of extermination? Can you murder a billion trillion people, a million intelligent species, all merely to preserve your race's ignorance?"

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Sacra's eyes closed; I was afraid that signified resignation, that it meant "yes." My heart felt as if it were beating in my throat. The thunderstorm I'd been hearing now loomed high over the horizon, profiling the tiny alien in orange clouds.

"Captain," Sacra finally said, "again you speak the truth." Her eyes flashed open, and I felt her fury once more.

"Yet you have no right to speak to me as you have. You—whose entire life could fit into one moment of mine—are incapable of fathoming what my duty has cost me and the other sentinels. I have wallowed in the rot of a thousand alien minds, I have swum in oceans of blood, and I have not emerged unchanged, untainted." Her hands rose above her head and fluttered like scarves in a wind.

"Yet, through sharing their horrors and performing my own," she continued, "I have learned the value of peace in a way the rest of my people—who live in perpetual peace—cannot imagine. I have lived more than ten of your lifetimes. *You* are the infant." She closed her eyes, and her mouth fell open. A thin wail swelled from deep within her.

Then her eyes opened, and I felt anger mounting in her greater than before, but not the aimless energy of hate; it was more like the anger one feels when about to begin the final assault against a nearly impregnable fortress. I could feel her preparing for her loathsome duty.

"Sacra!" I shouted. "Why must it always be this way? If you have changed so much during your centuries as sentinel, how can you still believe in your . . . disgraceful duty? Most of the time, I solve problems without firing a weapon. I'm a soldier and don't pretend to be any kind of planetary guardian; that's for the administrators to take care of. I just command special mission crews. But if *I*, whose job it is to kill, can execute my duty without force, then surely *you* can, too."

Rain began to rush down into the tall weeds close enough for us to hear. The breeze whistled across my faceplate. Sacra rose up within her bubble, looking taller on her flippers than before. The emotions she had been pouring out dwindled; soon, all that remained of our telepathic link was a pounding headache. I felt afraid again, this time my own emotion: Was she going to leave us here, impotent and useless, while she went off and erased humanity from the galaxy?

"You are right, Captain," she said. "The price for my people's ignorance is too high. Too many new races are arising. Xenocide on the scale you describe in this age of new sentiences is unacceptable.

"I have a new duty. I will collect the other sentinels from their distant duties, and I will share with them our conversation. Then we will teach the rest of our people.

"It will be a time of revolution, a terrible time, thanks to you." I felt a trace of her anger again as she accused me. "But this price will at last be acceptable." Then she *smiled*. I'm sure that was for my benefit—learned by osmosis from peering into my brain—since a smile is such a human thing, so ungainly on her flat face.

Sacra gave us another ride, to Kosmos Marines High Command. There, the Galactic Alliance Security Board, in private session, agreed to carry out my recommendation and shroud the Ryon 312 system in a complete travel ban until the Ryonians decide to enter galactic society. In return, Sacra promised that neither she nor the other sentinels would weed Humanity from the galaxy. After witnessing a demonstration of her destructive power directed at what had previously been a decommissioned carrier, the Board considered the deal a fair one.

I wonder how galactic policy will change. I wonder *if* it will in the long run, if we can survive our own fear of

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one another and the other alien empires.

So now I am Captain of First Kosmos Marines Outpost, Second War Wing, Ryon 312 Division. My first permanent dirt job in twelve years. Two cutters patrol the system, though their crews have no idea why. Down here on Ryon-C, two dozen Marines dig hot chambers beneath the desert planet and—when the digging shift is done—monitor the system for intruders or keep our heavy antispacecraft weapons tuned up.

A handful of us—we eight who weren't allowed back into the regular Marines since we knew too much—try to figure out what we witnessed, try to imagine what must be happening on Sacra's World, which is what we now call Ryon-D. Though we're here until retirement, our morale is good. I mean, how many jarheads can say they saved the whole human race? Or that they nearly destroyed it. Either, I guess, is something for which High Command would award a medal.

Sacra's decision to force her people to mature must be a mighty burden. I wonder what the inside of her mind must be like, how dark it must have grown hauling trash and then incinerating it, how ten lifetimes of the worst imaginable Special-Ops work must feel. Dark, yes, but perhaps more enlightened than any ten humans could hope to be.

On long, cool nights after long, hot days, when it's safe to emerge from my underground command to watch snake-like things race across the ocean-sized deserts of Ryon-C, I picture Sacra sitting in her ethereal bubble, a world away, contemplating me and my species as her own writhes in labor pains or war or both. I imagine her dreaming of a day—perhaps far distant, perhaps never to arrive—when the Ryonians emerge from their shroud, still godlike yet cleansed of their murderous fear.

Perhaps, on that day, the few surviving races who crashed those alien spacecraft into her oceans will join us in a more civilized alliance of species. Hell, maybe on that day our own race will treat itself . . . humanely. I picture Sacra smiling, a lipless gesture more like a child's pencil rendition than a real smile, reaching her handkerchief hand out through the blackness between the stars, to touch the hand of a changed human, one perhaps entirely unlike me.

Then there will be no need for people like me, nor Ryonians like Sacra. ■

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BIOLOG Jay Kay Klein

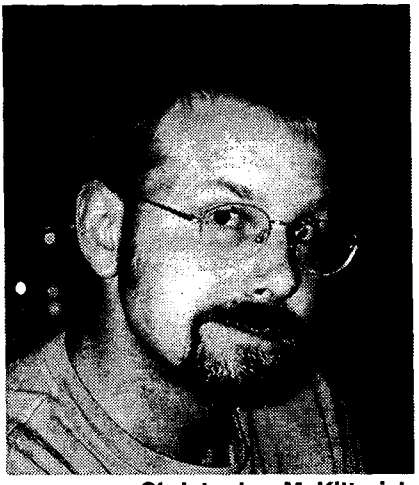
Born July fourth, Christopher McKitterick might have grown up writing patriotic songs as George Cohan did. The sight of celebration rockets sent Chris in another direction. His first published story sale, in the May 1995 *Analog*, featured Robert Goddard and Wernher von Braun as central characters in a novelette, instead of the usual short story first sale. Von Braun himself was no stranger to SF, and attended the 1947 world SF convention in Philadelphia, where his one-time rocketry colleague and *Analog* contributor Willy Ley introduced me.

When his dad was drafted and sent to Korea when Chris turned five, his mom defied regulations and took him there, too. After that, it was mostly Minnesota near relatives. Schooling was in a town so dismal and dismally named that the wonder is that Chris sank roots into the intellectual hardscrabble and published two short SF stories in the high school paper.

Wide-open spaces permitted practical rocketry. He constructed about two dozen solid- and liquid-fueled rockets from scratch. Some actually lifted off the launch pad. Others miraculously failed to kill anyone. Von Braun's first V2 demonstration had problems, too. Herman Goering observed the exploding fireball that traveled a few hundred meters and commented, "A spectacular short-range weapon!"

When eight, Chris wrote an SF story about a high-tech hula hoop. The protagonist stepped through the hoop to the Cretaceous and into the path of a Tyrannosaur.

Reading SF enabled the boy living in Nowheresville to explore the universe. At the University of Minnesota, Chris studied astronomy and psychology for four years, then transferred to the University of Wisconsin at Eau Claire for an undergrad degree in English. He was a



Christopher McKitterick

regular contributor to the college literary magazine. A physics professor and astronomer got him jobs in the local observatory, college observatory, and planetarium. Along the way, he helped children in astronomy classes build around a hundred telescopes. Two were his own, including a twenty-four-inch mirror.

An MA in creative writing came from the University of Kansas, where long-time SF author James Gunn was chairman of the English Department. Chris is currently into a new novel, and revising three earlier ones, with short fiction on the way, too. Editor Stan Schmidt continued the *Analog* tradition of helpful advice to new contributors. Chris found this encouraging and it gave him a try-again spirit.

Chris looks upon SF as the key to the future, engaging young minds in the romance of science and space exploration, along with the expectation of radical changes. He only fears that modern children may lose literacy and merely watch watered-down SF on HD TV. Chris urges exposing children to written SF to avert another Dark Age. ■

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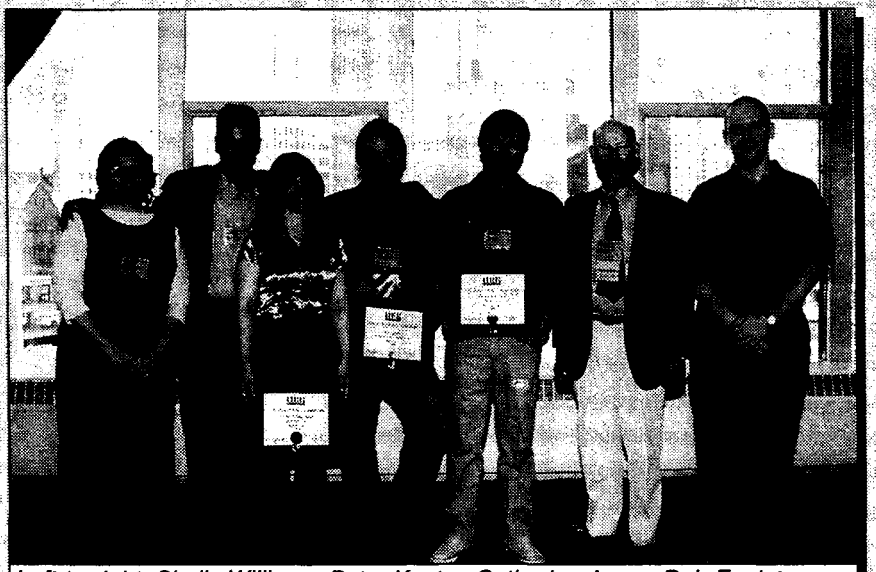
The Analytical Laboratory Awards



Left to right: Sheila Williams, Peter Kanter, Catherine Asaro, Bob Eggleton, Allen Steele, Stanley Schmidt, and Daniel Imal. (Photo: Beth Gwinn)

The Analytical Laboratory awards breakfast was held May 1, 1999, at the Marriott City Center Hotel in Pittsburgh, Pennsylvania, during the Nebula Awards weekend. We were pleased that so many of our winners were able to be there. In attendance were Catherine Asaro, whose story "Aurora in Four Voices" won for best novella; Allen Steele, whose "Zwarte Piet's Tale" won for best novelette; and Bob Eggleton, who had the winng cover for "The Ice Dragon's Song." Unable to attend were Tom Ligon, whose "The World's Simplest Fusion Reactor" won best fact article; and Stephen Baxter, whose "Moon-Calf" won for best short story.

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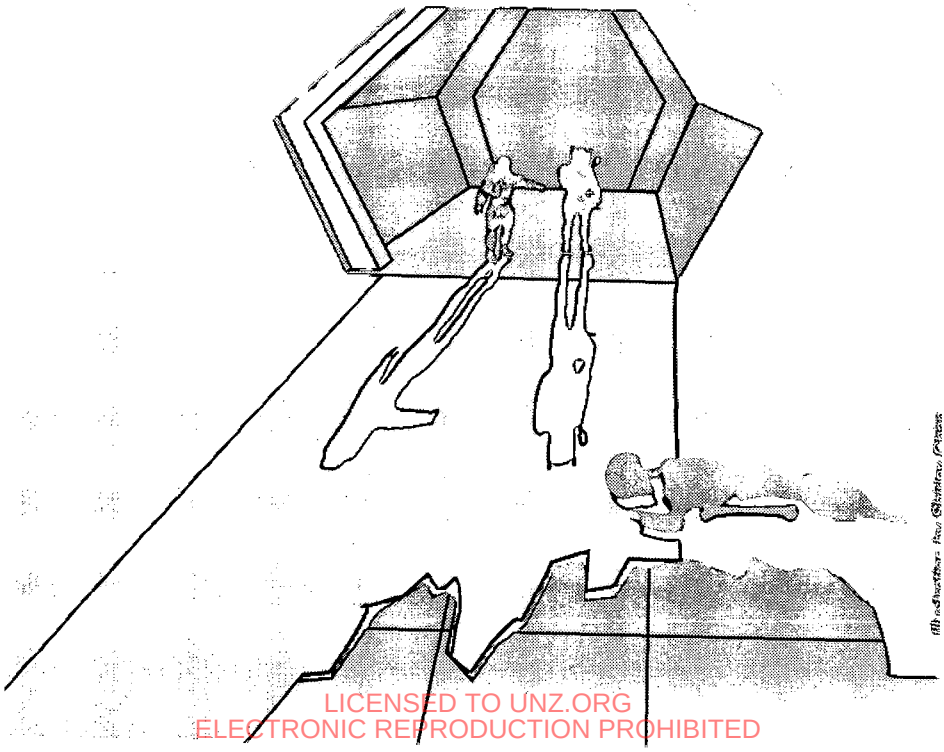
Ramona Louise Wheeler

THAT SLEEPER IN THE HEART

Some things, by their very nature, are very hard to investigate calmly and objectively. . . .



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The derelict starliner was enormous and dark, looming up in front of them as big as a moon, a black silhouette that engulfed the stars. She was crossing the *Yankee Shadow*'s trajectory, and, with just a little bit of luck, the *Shadow* would hit her dead center. At a quarter the speed of light, it was going to be a spectacular meeting.

Onboard the *Yankee Shadow*, the captain and first mate had no opportunity to react, not even to make a decision regarding their destination or their limited fuel supply. The starship's automatic deflection systems took over, with clanging alarms to warn of an abrupt and high-speed change of course.

Captain Raymond Harris, seated at the bridge, leaped to his controls, startled into full alertness by the noise and sudden course-shift straining the very bones of his ship. By the time his partner, Rokey, had been wakened in his seat by the clamor, it was over. The *Shadow* was braking with painfully extravagant use of fuel, managing to transform the collision trajectory into orbit around the giant luxury liner. Captain Harris had programmed and trained those automatic pilot systems himself. The *Yankee Shadow* was going to save their lives, no matter what it cost.

It cost. Once in orbit, there she would have to remain. There was no longer enough reaction mass left to break free and go anywhere.

The automatics had burned up the *Shadow's* entire meager supply of hydrate fuel cells, "pressed ice" as it was known in spacer circles, in order to decelerate, diverting their trajectory from a crash into an orbit around the giant starship. They had come through the Intraspace window with just enough to get to the fuel station in this system and land for refueling, counting on a little luck along the way. Luck had brought them instead into a dead-end orbit around a dead hulk. They had battery power for life support and some anti-gravity control, but without adequate energy to push, they were stuck in this orbit. That derelict starship was *big*.

The *Yankee Shadow* had dropped out of the Intraspace window in a system that was, according to all the map books, Coast Guard approved and travel-lane restricted despite its extreme remoteness from all centers of interstellar civilization, and its even more extreme isolation from official connections to things like the Coast Guard. The *Shadow* should have had a clear lane between system entry and landing at the fuel-station stopover on the single planet listed in the books as worth stopping at. Everything else in the system was virgin territory, explore-me-and-die type planets, and no one had found anything here worth risking the "and-die" part.

This ghost ship, this giant, derelict promise of salvage splendor, had wandered in from the everlasting dark of Intraspace. While still alive and sailing among the stars of the Milky Way, she had been a beautiful ship, of the wealthy Bell Crystal line, a magnificent luxury starliner built for rich people from rich worlds on slow cruises to rich vacation spots. There was room for a small city inside. The transparent spiral of the Intraspace drive engines was wrapped around the globe ship like a glass snake coiled around a glittering Tiffany egg. Even in death, she was a beautiful thing.

Their timing in coming out of the Intraspace window had been perfect—even five minutes difference either way and they would have missed the ghost ship completely, free to continue on to the fuel station and safety. Once the excitement was over, and they were certain they were alive, they found there was an automatic radio beacon with a recorded warning about the derelict's path.

The ten-year-old message wasn't encouraging, either. It identified the derelict starliner as the *Narridge Hoad*, worth a vast fortune in salvage, but ap-

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parently impossible to collect. "The damn ship's haunted," the message announced, the voice of the man giving the message sounding angry and confused. "She killed every damn thing onboard."

He told them about how the *Hoad* had come through the Intraspace window a decade ago, unexpected, unscheduled, dead and voiceless, but heading for a direct hit on the fuel station planet at very high speed. A tug ship had gone out and towed her into a stable solar orbit, thus saving the station world, but the tug had not herself survived the task.

"The *Hoad* is a death trap," the message went on. "Don't board her. Don't land on her. Don't even orbit." The man in the warning message looked damaged, with dark circles under sunken eyes, and raw scratches on forehead and cheek. One arm was roughly bandaged with torn cloth. He had a parrot on his shoulder, and the bird had also been through an ordeal. He sat in a ragged, hunched crouch, his crest missing half its feathers, and the skin around his yellow eyes was bare and puffy, as if a bird could cry.

"I'm Captain Melchior of the *Blue Heaven*," the man in the automated message said. "We went in to rescue the tug crew after they slammed into her side—that was a damned peculiar accident in itself, if you ask me. Tow cable blew and spun her out of control from its oscillations. I had a crew of six when I went into the *Hoad*." He shook his head in dismay, gesturing to the parrot. "Only Danny here made it out alive with me. Even Dan's little cousin Albert was lost."

"They ate him," the bird broke in. His voice was a harsh imitation of his owner.

"We did *not* eat him!" Captain Melchior exclaimed, turning his head to frown at the bird on his shoulder.

"They ate him," Danny bird repeated.

Melchior turned back to the screen, explained with an apologetic smile, "The damn bird panicked and flew into an open circuit, and it fried him."

"And then they ate him." Danny Bird blinked around at them with sullen bird eyes.

"I'll eat *you* if you don't shut up about that. We didn't eat Albert. He fried himself!"

The bird drew his head down to its shoulders, ruffling feathers stiffly.

Captain Melchior shook his head sadly. "I got to get us out of here. Dan never talked like this before. It was as bad for him as us. That ship is death. There's no treasure. All you'll find in there is Death Walking."

"They ate him," Danny interrupted.

"We did *not* eat him!" Melchior put out a hand to Danny and set him off screen. "Don't mind the bird," he said. "Just stay the hell away from that ship!"

"That's a big help," Ray said unhappily after the automatic message had signed off.

"You think they really did eat the parrot?" Rokey asked.

"Wouldn't you?"

Rokey shrugged.

"It's a cold universe out there, old man," Ray said to his partner with a grin. "Birds get eaten."

"Even talking ones, apparently."

Ray chuckled. "Especially talking ones."

Rokey pushed himself up from his copilot's seat at the dash. The big Wozurn's joints creaked as he stretched his arms, groaning at the stiffness, trying to make his fingers work. He shook once sharply to resettle his pelt of thick, black fur, and then wished he hadn't. He had been asleep at his controls, and his eyes, usually copper-colored, were dark red with fatigue and hangover. His big, triangular ears were still cold, still ringing slightly. Even his whiskers hurt, all nine of them. Rokey tried not to let them move as he spoke. "Want some breakfast?" he mumbled to Ray.

Ray shrugged. "I guess." The Earthman and the Wozurn were alien to one

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another, but it was the ways in which they were alike that kept the peace onboard the *Yankee Shadow*.

Ray looked up at Rokey and frowned. "Should I make breakfast for you?" Ray said. "You look awful."

Rokey grunted and turned to go out. "Since when did you learn to cook?"

As their orbit carried them in view of the remains of the tug that had crashed into the liner, Ray raised all the *Shadow's* long-range scopes and studied the wreckage carefully, in close-up detail. After a time he sat back in his seat, staring gloomily at the ship. She filled the view everywhere.

Rokey could see the troubled expression on the man's lean face settle into angry lines. Rokey knew when his captain was trying to digest unpleasant information.

"I spent hundreds of hours as a little kid crawling around the hull of our ship looking for line breaks," Ray said finally. "As soon as I was big enough to fit into a skinsuit, Dad started teaching me ship's maintenance. He used to say, 'Little eyes and little hands can find little problems, and stop them before they become big problems. That way little eyes and little hands will live to grow up.' So I looked for the little problems."

"Your Dad talked like that, did he?"

Ray shrugged, flashing a quick, pained grin at his alien friend. His green eyes were suddenly clear and deep with memory. "He wasn't too comfortable with kids," he said. "We got on better once I grew up."

Ray was roaming the galaxy trying to find his parents, separated from them by a military warrant when he was barely out of his teens, and Ray was not a young man anymore. Rokey changed the subject. "You think that cable was deliberately cut?" he asked.

"I know it was," Ray replied. "Space rock leaves carbon streaks across the face of the cut, and that makes the cut sparkle. That cable was burnt smooth, and at a clean angle. I can tell by how bright it shines that it was laser-cut. I'm certain of it."

"Evidently someone wanted to sabotage the towing operation, but why? They didn't know she was coming. Or so they say."

Ray did not answer. He was leaning forward at the dash, directing the *Shadow's* scope cameras with deft, sure gestures. The view in the main screen shifted from the black tangle of floating tow cable to the wreckage of the tug. A lone corpse spun in lazy circles, flung out of the ship but caught by its safety line. The arms were spread wide as though in greeting, and the ice frozen on the face glittered as the body circled in its endless dance with the death ship. The tug was buried in the side of the starliner, with only her drive tubes and the tow cable visible above the ship's skin. The close-up in the monitor showed that the starliner's automatic repair systems had sealed the skin around the wreckage of the tug, gluing her into place where she had died.

"We'll have to go in through the *Hoad* herself to get to the tug," Ray said, gesturing to the screen. "We'd have to cut through the drive tubes to get in otherwise, and the *Shadow* doesn't have equipment for deep space work."

"Why should she? You refuse to do hull maintenance, and I don't know how."

Ray grimaced curtly and shut off the monitor screen.

"Why do we have to get to the tug?" Rokey asked him.

"Pressed ice," Ray said. "Tugs carry good supplies, lots of backup. There should be some we can salvage to get us out of here. We only stopped by here for fuel anyway."

"How are we going to get down there?" Rokey asked. He was already getting a feeling of being trapped. "We're out of fuel!"

Ray's discomfort showed in his face,

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but he put on a brave smile. "The computer has done the math. We only need a little bit of reaction mass to brake enough to fall down to the surface. I can find enough for that if I empty out the weapons locker. We don't need much. I just have to time it so that we drop into one of the landing bays."

"How very clever of you and your ship," Rokey said lightly. He tried to smile. He could see by the slight knit of Ray's brow that he was only moderately certain of his plan.

"It will take about four days for us to fall all the way to the surface," Ray said. "You've got time to take a nap."

"And a meal," Rokey said as he went out. "We may need a good meal before going into that place. Death Walks, remember?"

Ray said nothing, but sat staring at the beautiful dead thing turning slowly in his view.

Ray was very clever about the maneuver, but it was close. Rokey said nothing, watching the gauge lines and scope readouts with remote attention. Rokey trusted Ray's instincts with his starship, and he had long ago learned to wait until after the disaster to ask Ray to explain.

The solid thunk of the docking grapples making contact with the *Shadow's* landing gear was reassuring, despite the air of mystery that surrounded the *Narridge Hoad*. They waited to find out if the starliner's automatic systems still functioned adequately to restore the atmosphere in the docking bay. All systems worked. The passengers and crew were dead, but the ship herself still lived, awaiting command.

"Suits," Ray said tersely. "Until we know what killed those people."

Rokey made a face, whiskers drawn forward tightly, but he did not argue. Death came in many forms, carried on many vectors, hiding in innocent, open places. Even the spacesuit might not be enough to protect him from whatever haunted the giant cruiseliner. He went to get his suit out and check the seals.

Rokey, once the exalted "Lord Rokhmyr, Earl of Rokherton Keep and President of Rokherton University," was nearly a hundred years old before he ever put on a spacesuit, but that day was itself more than a century and a half ago. He had started young for people of Wozur, Rokey's home planet, but at any age, Wozurn fur pelts just don't fit all that comfortably inside plastic casing, no matter how skillfully designed nor how patient the wearer. Worst of all, you can't smell anything inside a spacesuit except your own biology. Rokey's ultra-refined sense of smell was not only central to his sense of orientation, but also central to his sense of joy in life. Spacesuits weren't just isolating, they were boring. He studied the dense black fur of his forearms with a twitch of his sensitive whiskers. The clutch and grab of the suit sleeves was always the most uncomfortable, especially if he had to do any shooting. Rokey's suit was transparent, with a big, glasside globe helmet that gave his ears and whiskers room, and a ring of bubble filters like fat black beads around the sealing rim. If the atmosphere wasn't too poisonous, the suit would let some scents from the outer world filter through, some awareness of the breezes and the movements of the air, but not this time. Rokey closed these off, sealing the suit into a self-contained, vector-proof environment. He hoped.

Their suit radios carried every exhalation and sigh. On ordinary spacesuited ventures, they put on the audio filters to screen that out. The sound of someone breathing in your earpiece for too long can produce strange, angry thoughts, but in this case, Rokey felt that the sound of his partner's breath would be a subliminal cue that would help compensate for the lack of smell. Going out into a pitch-black night

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would have been less troublesome for Rokey than the blocked-smell blindness of a spacesuit. In a dark night he could at least still smell his way around. He couldn't find his way around *inside* a spacesuit in broad daylight, and that made him as nervous as the memory of Captain Melchior's anxious twitch, and the parrot with puffy, tear-strained eyes.

Rokey returned the suit to its locker. If he was going trekking through a ghost ship while uncomfortable, he should at least have a good meal first. Ghost-hunting should always be done on a full stomach. Rokey was certain of that.

Captain Ray Harris' long, lean self, tall and too thin for Rokey's taste, made a gold-coated wire sculpture once suited up in his elaborate and shiny spacesuit. There were scorch marks along the back tanks and across the thighs from one of the captain's earlier encounters with innocent native confusion. Ray could have cleaned the carbon-scoring away completely, but he left it as reminder to watch his back when in alien swamps.

Ray and Rokey were not greeted by a swamp this time. The enormous landing bay of the *Narridge Hoad* was as elegant as a ballroom, all its ornate fittings polished and gleaming despite the abandonment that shrouded every dark corner, despite the emptiness that echoed. They both felt the need to speak in hushed tones, or perhaps even to whisper. The subdued lighting was intended to be a gentle greeting to disoriented travelers, but here and now it seemed the subtle lighting of a tomb. There were no hard shadows anywhere, and the exits would have been hard to find without the glowing arrows embedded in the floor everywhere as guides.

Just inside the main entrance foyer, a long-dead corpse lay sprawled in loose shapes, a pile of bones and fabric heaped against the door. Deep scratches, short and furious, marred the hard mahogany veneer, showing the ship's steel beneath.

There were words on the wall above the corpse, scrawled by finger smears in some unthinkable ink: KILLED BY THAT SLEEPER IN THE HEART!

"It's hard to tell after so much time," Ray said. He was on one knee beside the corpse, examining it with the scopes of his spacesuit helmet-lenses. "But it looks like the classic blunt-instrument-to-the-cranium. I think that's the cranium."

Even the native species of the dead alien was difficult to discern, dissolved by death into the anonymity of the basic humanoid form. The bones weren't Earther but that was all Ray could tell.

The airlock opened when Rokey put his hand to the control panel, and the corpse collapsed across the threshold with a soft swishing noise as though sighing with relief to have finally crossed the boundary it had guarded so faithfully for so long. Ray and Rokey had to push it inside so that the airlock could close. The body fell apart as they moved it, leaving a jumble of parts beside the door.

The ship's automatic lights came on as they entered the main lobby. All was silent, and the darkness seemed to flee into corners and hide behind lounge chairs and travelogue displays. An eerie jitteriness hung in the air, dimly colored sparkles just out of the corners of the eye. Ray hurried over to the directory kiosk at the center of the open lobby, to study the ship's layout displayed there. Rokey trailed after, looking around at the luxurious space and shaking his head. There was something very wrong about this ship. He could feel it in the pads of his feet, feel it resonating in his sensitive face whiskers despite the isolation of his spacesuit.

"OK, we take that exit," Ray said, pointing. "But the way this ship is laid out, it will be a long walk to the crash site."

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"I wore my comfortable shoes."

"I bet inside that spacesuit you're barefoot."

"Isn't that what I just said?"

The ship was dark, but Ray and Rokey's living movement activated the corridor lights to a nightglow softness wherever they entered. The ship's automatics had translated the sleep of the dead as her passengers' night time, and kept the corridors dark for their final dreams. The *Narridge Hoad* had been carrying tens of thousands of passengers. Bodies lay in mummified poses at every turn of the corridor, and piled in the crossways. The immediacy of death was dissolved in the slow horror of desiccated flesh and empty eyes. Over the years servomechs had cleaned up the blood around the fallen passengers, and kept the corpses tidy. Rotting flesh was neatly carried away, and white bone showed in the smaller bodies.

The passengers and crew were predominantly of Earth descent, or at least humanoid, but there was also a good percentage of Arrglyddians fallen dead. The huge saurian aliens had taken many others down with them. Their dinosaur-like bodies were surrounded by piles of dried corpses, broken and flung against walls and into corners. The deep gouges of the Arrglyddians' powerful hindclaws marred the luxurious elegance of the ballrooms and corridors where they had died, with chandeliers pulled down from the ceilings, furniture crushed and doors buckled.

On the walls above every corpse, hand-scrawled in the same gory ink, was the same phrase, in the same barely legible handwriting: KILLED BY THAT SLEEPER IN THE HEART!

Ray's sense of direction inside a starship was as reliable as instinct, and Rokey followed his captain without noting direction or place. The gloom and resonance of pain that met them wherever the lights flared on created a growing sense of danger in Rokey's own instincts that seemed to blur his peripheral vision and rattle his bones. There was something wrong about this ship, something more wrong even than the violence and tragic death everywhere, and the wrongness increased with every turn along the way.

"How much farther?" Rokey asked Ray finally. His voice sounded harsh inside the globe of his helmet.

"Three corridor lengths and two flights of stairs," Ray said curtly as answer. "Ten more minutes."

Rokey could see, even through the helmet, that the man's face was pale, his mouth set in a tense, angry curve. Ray was not watching where he walked, but studying the suit monitor readouts and visual displays from his various suit lenses in his heads up display. He was studying the passages in a variety of wavelengths of light, searching the walls and doorways as carefully as the corpses they passed.

Ray stopped finally, and turned to Rokey behind him. "Look at this," he said. The taut concern in his voice caught Rokey by surprise. The man was afraid. Fear infuriated Ray, and this conflict of emotions rang through his voice. Ray had dialed up the brightness of his heads-up display so that it reflected more clearly across the front of his faceplate, visible to Rokey, with the ghost of Ray's face behind. "Something is drifting through here in the infrared," Ray said. "Do you see it?"

Both men stood unmoving as if staring face to face. Rokey saw nothing on the faceplate but the rippled shapes of their own infrared outlines. The corpses didn't show. They were all long cold. Tense minutes passed, and Rokey still saw nothing but Ray's green eyes searching the display. Then Rokey watched those eyes track something.

"There!" Ray exclaimed. "Did you see it?"

"No," Rokey said. A cold hand seemed to brush against his ears, sending a shudder through his muscles. "No,

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I didn't see anything, but I can tell that you did."

"Grid," Ray swore softly. The projected display disappeared, showing Ray's pale, angry face clearly again. "I saw it plain as I see you."

"Did it look anything like Death Walking?" Rokey said, trying to sound lighthearted.

"Yes," Ray said uneasily as he turned to continue on down the dark corridor. "That's just what it looked like."

KILLED BY THAT SLEEPER IN THE HEART! was smeared on every wall, chronicling the death over and over with the same declaration. Children and pets had not escaped the massacre. Indeed, deeper into the ship, they seemed to have drawn a particularly virulent form of the madness to themselves, as though their very innocence had driven some violent frenzy in their attackers.

Both men had their suit recorders on, audio as well as trideo, and neither could bear to look, finally letting their suit lenses take in the scene. The soft velvet comfort of this luxurious, elegant starship was the dignified wrapping around death and terror, a luxury made stark by the dried and tidy dead.

Rokey kept his eyes on the back of Ray's goldtone suit and tried not to step on the man's heels.

The broken body of the spaceship tug had been shrouded in threads of dried foam by the persistent actions of servomechs through the years. The side of the tug that had struck was crushed, and melted into the starliner in places, as though the crash had merged them into one.

Once they stood close enough to see details, Rokey saw that burnt feathers stuck out from a smashed panel in the damaged hull. Blackened bird bones were still meshed with the broken circuit that had killed it. From the look of the charred flesh, Melchior had told the truth.

"So they didn't eat him, after all," Rokey said. "I wonder why Danny thought they had?"

"This place is non-stop paranoia in every breath," Ray said tautly. "What else would a bird who hangs out with spacers be paranoid about?"

Rokey chuckled. "Being eaten."

The starliner's outer hull had been repaired around the tug, and sealed airtight. Left to the task without human guidance, random errors had built a bizarre termites' nest of protective layers around the tug's remains, a servomech's simple concept of fulfilling its directive to protect its human charges from themselves as well as from the implacable nature of reality. The *Narridge Hoad* had failed to protect her human charges from the Sleeper, whatever that was, and the residue of that tragedy touched everything.

"Can we get in there?" Rokey asked.

"We have to," Ray answered. "And fast. There's something wrong with this place. I can feel it."

Rokey could feel it as well. The wrongness seemed to grow with every breath, every step forward they took. His fur trembled with it, ripples of black energy that tugged at the back of his eyes and tickled his ears. "Good plan," he said to Ray. "Let's get out before the Sleeper wakes."

They climbed in through a great, wide split in the tug's side, webbed around its edges with those dried threads. No automatic lights came on in here. This ship was truly dead, and would not wake again. Their suit lamps showed the extent of the wreckage—smashed deck plates and twisted hull struts with splayed photon tubes festooning cracked control panels. Ray had to stop often as they worked their way to the engine room. The damage was so severe that it was difficult to identify what part of the tug they were in. Rokey began to worry that Ray had overestimated the possibility of finding usable fuel cells here, but he kept that

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worry to himself. Ray was clearly agitated enough on his own.

They did not find bodies on the tug, despite the severity of the crash. Captain Melchior had apparently gotten them all off the tug before losing them to "That Sleeper In The Heart" on the way back to the *Blue Heaven*. Rokey began thinking about that as he followed Ray's precarious passage through the wrecked corridors.

"Here it is." Ray interrupted Rokey's gloomy thoughts, stopping before a broad stretch of hull.

The deck was canted at an unpleasant angle, and Rokey nearly lost his balance trying not to walk into Ray. He caught himself with one hand against the hull, and was surprised when it crumbled away at his touch. "What's here?" he said grumpily as he hastily checked his glove and sleeve for tears.

"Engineering." Ray said tersely. "If there's any pressed ice left, it will be on the other side of this stretch of hull here." Ray pushed against it as if it would fall away at his touch.

It did, crumbling into sharply cornered shards as it fell. Both men leaped back abruptly to avoid the falling pieces, and they kept moving back as the cloud of carbon dust rose slowly around it. The black dust rippled in the air as it fell, as though dancing with the light. Once that had settled, the men returned to shine their lamps into the darkness of the chamber beyond.

Ray told Rokey to wait in the corridor, and he climbed over the debris into that dark. Rokey stayed put, peering through the hole in the hull to follow Ray's progress.

Rokey's growing anxiety was stretched thinner by the time Ray returned carrying a simple floater pack that trailed behind him. Two small cartons were strapped to the pack. Rokey knew at once what that meant, but he stood stoically waiting for Ray to tell him.

"We've got enough to keep life support going," Ray said. His voice in the suit radio was level, calm, terrified. "Melchior was right. This tug died in a damned peculiar accident."

Rokey did not ask him to explain that. Some day, over drinks, Ray would put all the details into logical order for his partner. Rokey wouldn't ask for something Ray had not yet explained to himself. The edge in Ray's voice was story enough.

"Have I got time to sit down while you work out our next plan?" Rokey said. He was not smiling, and his voice held not the slightest note of mockery. The spacesuit had wearied him. He wanted to sit down, but in the suit, that wasn't easy.

Ray laughed, and the tension that had been gathering in the lines around his eyes eased into smiles. "I think we better both sit down," he said.

They did, in the corridor outside the dead hulk of the tug. Rokey regarded the meager supply of energy in the packages of pressed ice on the floater. Even Rokey knew how much time they represented.

"We have to go up to the bridge of the *Hoad*," Ray said after many long minutes of silence had become awkward. "I can look at the engineering logs there."

Rokey stood without speaking, and followed Ray as he walked away from the remains of the tug that had died to save the fuel-station planet from the dead *Narridge Hoad*.

The bodies were piled deeper, and the evidence of violence harsher as they approached the ship's bridge. The *Hoad*'s crew had barricaded themselves in as a last defense against some frightful enemy.

"Who were they fighting?" Ray demanded. He turned slowly on his heel, staring around in disbelief at the tidy remains of carnage. The blood had been scrubbed away by the patient machines,

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but they could not remove the looks of terror on the dried faces of the dead.

"What were they fighting?" Rokey needed to reach inside his spacesuit and comb down the ruff of fur around his neck. He was scared, and not about fuel cells or dead batteries.

There was also evidence that Melchior and his men had gone up to the bridge. Someone had pushed corpses aside and burned open the bridge entry.

Ray and Rokey went inside, guns drawn.

The bridge crew had met the same fate as the passengers. Some terrible violence had rent them all, despite discipline, training and an arsenal of hand weapons. KILLED BY THAT SLEEPER IN THE HEART was scrawled in foot-high letters across the floor and across the bodies in the path of the words. Ray and Rokey were both careful not to step on the lettering, although neither man was ready to acknowledge why.

Only the captain had remained at his post in the command chair at the center of the bridge. The rest were scattered, dead in groups and piles. The captain was a square, clean-cut man with big, sharp features and thick eyebrows that made a single straight line between his forehead and his eyes. His hands were straight and his bones were straight, and his bright white uniform was perfectly pressed. Even in death, he was neatly presented to the world. Someone had slashed his throat wide open, and the copious sweep of blood soaking into his white uniform was the single imperfection to his stylish, military facade.

They stood for a moment surveying the wreckage on the bridge, the extent of the damage.

"If everything up here has been wrecked like this," Rokey wanted to know, "Why have the life-support automatics worked for the last ten years?"

"Because they *are* automatic. On a passenger ship life-support systems have primary priority. The automatics are hardwired into the ship's superstructure itself. They'll run as long as they have access to the batteries, no matter what happens to the bridge."

"And we want to get access to those batteries?"

Ray nodded absently. He was crouched in front of the least damaged section of the bridge control systems, studying the surviving circuits with a close-up lens on the front of his suit helmet. Random lights flickered here and there in response to Ray's coaxing, flashes of voice recordings, but he was unable to pull up any coherent information. He fussed with the panel for a time, and finally got a sputtering display on one monitor. He stood up to watch it play, then ran it through it a second time.

"This is the last bit of data left in the buffer of the captain's log," Ray explained. "It wasn't hit when this panel was smashed up."

The captain was shown close-up, talking hastily into the log recorder in the arm of the command chair. " . . . until they break in here. I've never had a crew mutiny on me," he was saying. His straight black brows were knotted downward in an angry scowl, but his eyes were afraid. "I've never even heard of passengers on a luxury cruise committing mutiny. This is madness. The very fabric of this ship has gone insane. I can't stop it any longer. My own sanity is slipping." He looked around the bridge with growing desperation. Sounds of screams from off-camera cut across his words. "I can't get to the heart to stop it anymore. We're blockaded in here now. They don't know what's in the heart. No one believes."

That was all there was.

"Can you locate engineering?" Rokey asked.

Ray looked around at the savaged instruments and destroyed computer layouts. "Yes. It's got to be onboard somewhere." He turned away and headed for the exit.

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Rokey followed after.

The only ship's directories they could find were all passenger-oriented. Passengers did not need to locate engineering, and were actively discouraged from visiting there anyway. Ray did some educated guessing, and set off in a direction. Lights flickered on in their path and faded out again behind them as they walked.

Because the passengers had been kept away from engineering, the sullen sweep of death had not filled the corridors here. The three women who had been on duty were dead, though, sprawled awkwardly in their seats, limp rag dolls long ago gone dry and brittle. Each had been shot in the back by a hot, hard burn, taking out most of the spine, and the look frozen on their faces was that of surprise, not fear.

Ray worked around them, studying the control layout and touching knobs and keypads to test responses. Rokey wandered until he found a workbench he could sit down on. The dim lighting and hushed, strained atmosphere were taking their toll on his patience. "Could we just call the fuel station and ask them to deliver?" he said finally.

"I asked," Ray replied without looking up from the keypad he was studying. "Melchior's got the only spaceship in the system, and he says he won't come within a trillion klicks of the *Hoad*, not even to save his sainted grandmother."

Rokey grunted a soft, quick noise of shock, and then caught his breath. "Who would think a man like that would be devoted to his grandmother?" he said instead of the sudden expletives that had risen to his tongue. This information explained Ray's intensity and willingness to gamble on finding fuel cells surviving on the *Narridge Hoad*. Their only other option was to wait until another ship came through the Intraspace window, and radio them for either a lift or at least a phone call to the Coast Guard at their next stop—and hope they weren't the type who would consider the *Yankee Shadow* as fair salvage. This was a remote system, not on any regular schedule with anyone, and they might wait a long time for another ship to come through. Calling the Coast Guard was a genuine last-ditch effort: Coast Guardsmen were officials, and asked a lot of official questions in return for their official help.

"You kept that quiet a long time," Rokey said to Ray's back.

Ray did not turn around. "I figured you would worry."

"You figured right. Are you finding anything here?"

Ray sighed, and turned around to look at Rokey. "They're in the hold," he said. Ray looked down and touched the edge of the console where the dead women sat. "Before they were killed, these ladies were trying to debug the virus in the ship's superstructure command system that had locked the hold from the inside, which is something the cargo hold systems aren't supposed to do."

The long, chestnut-red locks of one woman were draped across the console where she had slumped forward. They concealed her face, and the rich curls were still shiny. The servomechs had tended the messiness of death here as well. Except for the burned-edge hole in her torso, she might have just fallen asleep at her post. Once Ray had stood for too long staring down at her, Rokey cleared his throat and climbed back to his feet. "Then let's collect our clues and have a look at what's in the hold."

Ray did not move right away. He was still staring at the redheaded corpse. The hand resting in her lap was all bone, even though the dawn-colored nail polish was still intact, still brilliant.

"The hold is in the very center of the ship," Ray said finally. "In a globe-design ship like this, the hold is put in the very core, in a null-*g* spot of antigrav field overlap."

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Rokey was not as familiar nor as comfortable with antigravity technology as Ray, and did not understand the significance of Ray's words. "OK."

"Do you know what they call the hold at a null-g core?"

"Not a clue," Rokey said. "Should I?"

Ray pulled himself away from the tragedy of red curls, and touched the controls for the floater pack which drifted up obediently to follow him. "The cargo in the hold of a globe ship provides a much bigger return than tourist dollars," he said. "For every dollar they get in passenger ticket price, they make ten thousand in cargo. Two passengers and a full hold can still make a run profitable, even for a luxury ship like this."

"Since when do luxury cruise lines carry cargo?"

"It's Bell Crystal Line's secret of success. That globe design gives them a lot of interior."

"And everybody wants a window seat when they travel," Rokey said. "I get it."

"That cargo is the life's blood of the company, so the hold in the center of the ship is referred to as 'The Heart.'"

Rokey sighed, wishing again that he could brush down the hackles risen along his back. "That sleeper in the heart."

Ray nodded. "Behind doors locked from the inside."

Rokey wished desperately he could comb down his mane. He shook himself roughly inside his suit. "So what's the really bad news?" he said to Ray. He knew there was more.

"According to what's left of the engineering log," Ray said, "that's where the pressed-ice supply was stored. Even after ten years there should be plenty to get us through the window and out of this place. If we can get to it."

"And get out alive."

"Someone's following us," Ray said.

Rokey glanced quickly over his shoulder. He saw only the dimly lit, shadowed corridor and the inevitable dead, but he had felt the shiver, the sensation of eyes watching his back. The hushed velvet stillness and soft light were bleeding reality away in a tangle of desiccation, bone and dread. Forms seemed to flutter at the edges of his sight, and he could hear something. He couldn't really hear it, but there was a sound.

"Everyone on this ship has been dead for ten years," Rokey said to Ray, "and now somebody's following us?"

Ray kept walking. "And now somebody's following us."

Rokey needed his nose. If he had been free to smell what was going on, he would have been able to tell at once if there were anyone else onboard with them. Sneaking up on a Wozurn is not an easy task, unless that Wozurn is scent-blinded by a spacesuit. Rokey was mightily tempted to remove the helmet, but the air of madness that hung everywhere in this ship seemed contagious, and Rokey was not inclined to tempt whatever vector was out there carrying that madness. If his suit could protect him. It was not protecting him from the growing sense of foreboding, of wrongness about this place.

Maybe something *was* following them.

Rokey stayed two paces behind Ray to cover his back, and kept looking over his shoulder. He began to see shadows moving.

Ray stopped abruptly, gesturing for Rokey to stop. Rokey froze. He could hear Ray's breathing in the suit radio, harsh and ragged, as though he were holding down a rise of emotion, or fear.

"What?" Rokey whispered.

"It's up ahead of us."

"You said it was following us."

Ray turned just enough to look at Rokey. "Yeah, I did, didn't I?"

"Does this mean we're surrounded?" Rokey was still whispering.

He regretted at once the flipness of

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the remark, but Ray grinned sharply. "It means this damn ship is haunted, is what it means," Ray said.

"Ghosts didn't kill all those people."

Ray boosted the power on the lamp on the top of his helmet and turned back to the darkness ahead. "What makes you so sure?"

Rokey wished he had an answer to that. He could feel the eyes all around them as well. He just didn't want to believe they were there.

It was a long walk. Ray had to burn open the locks on several doors marked "Staff Only" and, at each one, they went through with guns drawn, to meet with only the same sleeping darkness, the same carnage long smoothed away.

"What a great commercial this would be for the company that makes those servomechs," Rokey said at one point. "I can just see it—'More reliable than life itself'."

Ray was not amused.

In fact, Ray was becoming increasingly agitated. Rokey could hear it in the oddly spiked rhythm of the man's breathing in his suit radio. Rokey was accustomed to his partner's emotional interaction with the world around him, an interaction that turned easily to passion. Rokey considered this a sign of Ray's moral character, but sometimes it just plain infuriated him. Ray Harris did not know how to walk away from anything.

Rokey realized that a lot of things about Ray infuriated him, and having to follow him around in the dangerous dark, ice-fishing, was at the top of the list. Rokey's ears itched, and the fur on his forearms hurt now from the constant irritation of the suit sleeves. Wearing this ridiculous spacesuit was another of his captain's "I'm a wild starman" games, playing at space opera and saving all the ladies—all the redheads, anyway. Rokey wanted to go home to the peace and quiet of his own bed. It was damn noisy in this place, despite the constant hush of the dead.

Rokey caught himself at that, appalled at his own line of thinking. His ears did itch, and what was all that invisible sound?

"What's all that noise?" he asked Ray. His ears felt stopped up, as though there were a silence so loud that everything else was muffled.

"You're the one with the big ears," Ray snarled. "You tell me."

Rokey's alarm grew. It was Ray's voice, but it did not sound like Ray. There was a flat, frightened meanness totally out of character for the man. The dark corridor walls seemed to pull in, as though the ship were drawing a deep, eager breath.

"Captain Harris, what's that noise?" Rokey said distinctly. He stopped walking, and put his hand on the hilt of his gun. The touch of it against his gloved fingers shocked him, and he hastily put his hands behind his back, awkward as that was in the suit. He no longer trusted himself.

Ray whirled around, facing Rokey with an angry grimace twisting his features. His eyes were blazing with rage, and his face was white. "You're frightened by noises now, old man? Now I'm supposed to save you from things that go bump in the night?"

"Ray," Rokey forced calm into his voice. "What in the scubb's got into you?"

Ray blinked, drawing back as though startled awake. The rage drained out of his face, leaving his green eyes wide and scared in an ashen face. "I don't know, Rokey. I just . . . This place is haunted."

"I'm scared, too," Rokey said to him. "There is something wrong with this place. But it's not you, and it's not me. Just keep that in mind."

Ray nodded, struggling to calm his ragged breathing. "Sorry about that, old man."

"Never mind," Rokey said, "but what's that sound?"

"What sound?"

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"That sound that isn't quite there, that's too big to hear? You don't hear it?"

Ray grinned, somewhat recovered. "How do I answer a question like that?"

Rokey felt some of his angry terror fade. "Metaphysically absurd, isn't it?" He chuckled, shaking his head. "But it's there."

Ray looked down to his suit control panel, made some adjustments on the scanners, and then turned on his heel in a slow circle, searching the display on his faceplate as he turned. Halfway around the second time, he stopped, pointing down the darkened corridor. "It's up ahead of us, whatever it is." He shook his head as he read the data. "Puzzling. Some kind of sonic energy. It's off-scale but it isn't audible."

"I trust my bones," Rokey said. "And something's rattling them around inside me real good."

"I can feel my skull rattling around in my head if I don't concentrate."

That comment knocked loose a scrap of data in Rokey's mind, something that teased at his memory the way the dark teased at vision here. As they continued on, lamps set to bright, Rokey tried to chase down that elusive thought, but the growing pressure of the non-sound made all his thinking musty, second-hand, tired. He followed Ray's glowing figure, trying not to see eyes in the darkness behind them.

Continuing on became increasingly difficult, the sheer physical effort of lifting their feet and pushing the air aside to move began to drag on their muscles and scrape painfully at their joints. No matter how brightly they turned up the lights, a mist seemed to hang over everything, and, from the corner of the eye, the mist formed faces in outlines of smoke that melted away when looked at directly.

Ray walked with the forced stride of combat training, as though willing himself forward, and Rokey's fur rippled constantly with short, cold shivers of fright. It was, he noted however, a curiously impersonal fright, fear that seemed to grow out of itself, without any true source. Rokey told himself that this was a only a dead starship with an old tragedy, and they were just on a walk to borrow a cup of ice, nothing more. That touch of demon breath was an impossible fantasy. He was wearing a spacesuit. Nothing could touch him but the suit itself.

Then the suit whispered to him that she owned him, she had him surrounded, and she would never, never let him free of her.

Rokey screamed.

Ray was at Rokey's side in a flash, grabbing his hands as Rokey tried frantically to unlink the gloves. "Rokey!!" Ray shouted as they struggled. "What's wrong??"

The suit was laughing at him. Hysteria bubbled up in Rokey's throat, burning his breath away. The suit was going to suffocate him. "Let me out of this thing!" Rokey cried, writhing inside the constricting coils of the spacesuit. Ray would help him. Ray understood spacesuits, even haunted ones. "Get me out of this thing!" he pleaded with Ray. "She's gone mad!"

Rokey stopped struggling, his ears down flat to his skull. His copper-colored eyes were bright red. "Help me, Ray!"

The sound of the suit's laughter whispered in his ears, *"You're mine now . . . "*

"Hold still, damn it!" Ray ordered him sternly. "Hold still, and I'll get you out of there!"

Rokey froze, letting Ray undo the black-beaded rim seals around the helmet. For a wild flash, Rokey expected his head to come off along with the helmet when Ray lifted it away, and he almost screamed again. He backed away from the helmet in Ray's hand, thinking he could see a face dimly reflected there.

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Like a child being undressed from a snowsuit, he held out his gloved hands, impatient for Ray to remove them. "Get them off, please," he whispered. "Don't let her get me."

Ray undid the security seal links on the cuffs and slid the gloves off. He dropped them into the globe of the helmet, and stepped back, surveying his friend with a keen eye. "It isn't me, and it isn't you, remember, old man?" he said, with a trace of his cocky stance restored. "Talk to me."

Rokey tried to catch his breath, tried to hear the suit-demon, but Ray's focused attention had chased the sensation away, proving it to be terror from the peripheral edges of perception. Rokey felt shaken. The voice had been utterly real. He put away immediately the suspicion that Ray had played some cruel joke on him. That was less likely than his suit being haunted.

He explained to Ray what happened, dismayed by the tremor in his voice.

Ray began at once to unsnap the remaining seals on Rokey's suit, and helped him out of it. While Rokey smoothed his ruffled fur down as best he could with his hands, Ray shook out the suit and carefully folded it away, packing it into the big globe helmet. He strapped the helmet onto the floater with the cartons of pressed ice.

"I guess we've proven that whatever got these people can penetrate a spacesuit," Ray said. "It doesn't matter anymore if you wear it."

"Thanks," Rokey said to him simply. "I'm sorry. That was really not what I expected."

"Hauntings come in all colors," Ray said with a grin. "And now I don't have to tell you what I was seeing just then."

"What were you seeing??" Rokey exclaimed.

"Never mind, old man. It wasn't real, and now I know it."

"What in the blazing scubb is going on here?" Rokey demanded.

Ray tugged the floater handle to activate it. "Something deadly. Something that drove all those people to kill each other. And right now I'm really glad that I like you as much as I do."

Rokey felt a great sweep of relief, larger than the fear. "Thanks, mate. Same here."

There were fewer and fewer bodies as they got closer to the cargo hold entrance. Evidently not many had the courage to penetrate so close to this heart of evil. At the entryway itself, a lone body lay stretched out in a last attempt to reach the door. A bony hand pointed to it with clawed fingers. From the uniform, they could see that one of the ship's top officers had made the desperate effort to break through his own terror and get to the heart. What killed him was not clear, but his dead face was set in a terrible scream.

"The source of that energy field is in there," Ray said, looking up from the readouts in his suit monitor and gesturing toward the locked hold.

"And so are our fuel cells."

"Yes."

"And it's locked from the inside?"

"Yes."

"And you have a plan?"

"Isn't it your turn to have a plan?" Ray exclaimed. He was grinning. "I had the last plan. In fact, I'm two up on you for plans."

"I don't have a plan! I'm just following you."

"OK! OK! I've got a plan." Ray was forcing lightness.

The air was so thick with evil intention it seemed to push back at them. They could both taste the fear, but both, having overcome that fear now several times, were increasingly curious about the cause. They needed the fuel cells in that hold, but they needed answers now just as much, perhaps more. They could be fooled once, even twice, but not again.

The hold entry would not respond to any of Ray's deft computer work at the

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control panel. Ray gave up on the polite method, drew his laser, and slowly, methodically burned away the hinge bolts and the lock. He used up the last energy in his laser and finished the job with Rokey's, leaving it also drained. If there were no fuel cells here, their energy reserves really were at bottom.

The last bolt popped away, and the door swung open, teetered, and then toppled over, hitting the carpeted deck with a dull, heavy thud. Both men had guns drawn, even though useless now, expecting the dark of a cargo hold, but instead a dazzling light spilled out of the entry. Hot light and hot air breathed out across them, and with them the sound of hard, low, muttering laughter.

The light of the sim-sun in the hold was brilliant yellow, not the white medium of Sol, but a garish, hot brassy yellow that burned on every surface, and made the air molten and dense, a light heavy with the weight of its own heat. The throb of danger in the air was as dense, as metallic as the heat.

"You'll feel a gravity-interface step when you go through there, Rokey," Ray explained tersely. "The ship's antigravity fields are designed to weave a torus around the heart, so that the null-g section is suspended in the center, with the drive engines at the null-g poles, anchoring the field shapes to the hull."

"Ray, that makes absolutely no sense at all!" Rokey exclaimed.

"It does in the mathematics, trust me."

"Then make it make sense to me!"

Ray grinned sharply. "You will be encountering invisible steps, so don't watch your feet, feel for it with your toes, and you'll be lighter with each meter, no matter what the ground looks like to your eyes—keep that in mind."

"Minding the gap," Rokey grunted in acknowledgment. He let Ray go in first, watching him cross the force-field threshold before stepping inside. Each man had a hand held out in front of him like a talisman against the dangerous light.

Distance was dissolved in the light and the wind. The hold was a huge chamber nearly five hundred meters wide, globe-shaped, ordinarily filled with cargo in mesh bags hung by lines, floating in the null-gravity point at the ship's heart. This chamber had been transformed into a desert landscape, with towering sandstone monoliths standing around the rim, holding up the illusion of the hot sky overhead. The wind had carved them with its sand-edged teeth into careless demon shapes. The light was too intense to look at anything. Details wavered in the ripples of heat. Quavers that became voices and then wailing and moans of despair swelled up around them as though the ground groaned in pain beneath the pressure of their feet. Winds slashed at them in annoyingly irregular blasts, pulling and tugging at Rokey's ears with hard child fingers, mean and teasing. As their weight lessened, the wind threatened to blow them backwards.

Ray forced himself to concentrate on his suit monitors. "It's right ahead of us," he said. He had to force his tongue to shape the words. The awful dread had mounted to an unspeakable terror, and his mouth felt glued with wet sand. "Dead center of the ship, at the null-gravity spot," he said breathlessly.

"What's up there?" Rokey asked.

Neither man could see clearly what was hanging in the air at the ship's heart. The brilliant sim-sun dazzled vision. The erratic, insistent winds slammed at them with stinging sand, and steam swirled about a half-hidden mass ahead as big, as a whale, that looked, what little of it they could see, like treacle pudding serenely floating in the midst of a sandstorm. Red cherry knobs were studded randomly throughout the treacle and drifted across its pulsing surface, sinking in, popping up. Winds howled, rattling sand with the sound of angry sabers.

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All the fear, loathing, dread, depression, anxiety, spite, or hatred they had ever felt was now centered in and born out of that hideous, comical horror floating there—treacle and cherries possessed by demons. Waves of incandescent evil radiated from it, rippling through their flesh and leaving a cold, flaming resonance of terror in their bones. It darkened their vision, enfolding them in its perfect misery. Sand danced against them as though trying to warn them away.

Ray and Rokey walked toward it in tight step with each other. The treacle pudding became transparent, and one by one the red blobs split open to reveal golden orange eyes. All the many floating eyes were focused on Ray and Rokey. The transparent gel thinned and broke up into hundreds of skull-sized bubbles. These red-eyed bubbles drifted over slowly to cluster around the two men, staring and silent.

But with the opening of those alien eyes, the nightmare ended.

Ray and Rokey looked around in dazed surprise, aware all at once of a change so abrupt and total that it was as if they had both just waked from some dreadful dream. Yet they had gone through the nightmare together, and that made it real. Whatever it had been, however, it was over. The winds stilled, dropping the sands with a happy, cascading noise, followed by calm silence. The whispers, the moaning, the fear, everything stopped. Only the visceral resonance was left, already fading on the blood tides.

Their heads began to clear as the red-eyed bubbles floated up to them. The men lowered their weapons, confused.

"Good morning, gentlemen," the nearest bubble said to them in fluent SpeakEZ. It was as big as Ray's head, and floated close to his face to speak. "You are not in proper uniform, and I do not recognize you. Has something happened to Captain Walters?"

Ray could only nod. Rokey was still staring around stupidly, struggling to orient himself.

"Have we arrived?" the bubble-with-eyes asked. "Is this the Moon of Desdemona?"

The dead captain on the bridge might have been in charge of the luxury starliner *Narridge Hoad*, but the cherry-studded treacle in the hold turned out to be the owners not only of the *Narridge Hoad* but also of the entire Bell Crystal Line. Idalia Hoad, CEO of the company, was spokesman for the treacle. They were Urkaz, amoeba-like aliens from a distant rim world—giant, single-celled beings. They rarely traveled out of their home stellar system, despite owning the largest luxury-starliner manufacturing company in civilization.

When Ray and Rokey told CEO Idalia Hoad that Captain Walters as well as everyone else onboard was dead, and how they had died, the aliens all reacted with visible distress. The eyes closed and sank down into the bubble, which changed from a watery transparency to white and then frothy, sickly-green. "How horrid. How horrid," Idalia Hoad moaned.

"Why were you here in the hold," Rokey asked, "instead of traveling as passengers?"

"We were seeking privacy," Idalia explained to them once he had regained some transparency again. "Privacy in our world is difficult to find, and we had been through a stressful series of changes within the company. My family and I decided to sneak away for a rest, somewhere far away from everything." The voice was eloquent, sadness ringing through the vibrant tones. "We thought a vacation on the fabled Moon of Desdemona might restore our sense of purpose."

"This ship has been in orbit here as a derelict for a decade and more," Rokey said. "Why did it never make the news that all these people were missing?"

"I can't answer that, although we did

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go away in complete secrecy," Idalia replied thoughtfully. "Only Captain Walters knew we were on board. We had this cargo hold prepared as an environmental chamber for us to travel in because we are only comfortable in low gravity. We came on board disguised as luggage. We wanted to keep our homeworld press from following us. We needed a rest—although sleeping for that many years was not in our plans!"

"Is it normal for you to sleep that long?"

"Yes, but only under the right environmental conditions. We did not set the life-support controls in this chamber for the conditions in which you found us, and we were unable to control the conditions once we were locked inside. We had not planned to sleep during this journey, and we would never, under any circumstances, have allowed ourselves to fall asleep with humanoid aliens on the same ship with us!"

The emotional distress of that was clear. Idalia was not just embarrassed but was, for some reason, horrified that they had been made to fall so soundly asleep. Neither Ray nor Rokey pressed the issue. Idalia's despair over their long sleep was growing.

"I must explain all this to my family," Idalia said. "I would ask you if it is possible for you to take us off this accursed ship, and return us to our homeworld, to Urk? We would compensate you handsomely for the passage."

"It will take about ten days for us to get to the zip link station on Muriel and another three weeks for the link to Urk from there," Rokey told him. "I think the *Yankee Shadow* can manage that, once we have fuel cells from the *Narridge Hoad*."

"Please," Idalia said, his voice strange, "do not inform the people in this system that we were on board," he said to them.

Rokey could understand that, but had to ask, "Why trust us?"

"You were able to stand up to the noise." Idalia's words made no sense. "Not many have hearts and minds strong enough for that."

They didn't understand, but Ray and Rokey were glad to get off the *Narridge Hoad* and have an excuse to leave her behind. Even with the mysterious "haunting" ended, the ship resonated with the horror of tragic death and murder.

The Urkaz, now that they were awake and aware of what had happened, were anxious to get off the starliner and away from this system. They were afraid, and Ray and Rokey did not blame them. Even Ray felt sorry for them, once he had recovered himself from the fright. Transferring the treacle mass to the *Yankee Shadow* took some planning, however. In the null-g heart of the ship, they floated as large bubbles with eyes, but in a gravity field, they were flattened amoeboid crawlers, moving like flowing oil spills with eyes—fast crawlers, but it was a slow walking pace. Ray located a set of larger cargo-floaters and filled them to capacity with fuel cells and set off ahead, letting Rokey take the slower stroll escorting the alien executive and his family. Rokey also used a cargo-floater, with the treacle heads collected into the null-g field of the floater, cherry eyes shut tightly against the sight of the horrific landscape of their once-beautiful starship.

Rokey felt the distinct lightness of heart that comes with the waking reality after a bad dream. The dead in their tidied remains no longer threatened, and were now just horror movie props seen in the bright light of day. Being free of the spacesuit added to his relief, but the dead silence of the starship was itself now a curious phenomenon, disquieting despite the peacefulness and hush. The terrible sonic assault had caused Ray and even himself some awkward emotional vulnerability, but how could it have caused the madness and

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death of the entire ship? That same bit of information tried to float to his attention, almost making sense. There was something about low-end sonics and neurochemistry he had learned a long time ago in film-score classes and forgotten in the years of dealing with the realities of the film world and then the realities of the real world.

"'Our cruises run on laughter and music,'" Rokey quoted a line from a familiar ad for the Bell Crystal luxury starliners. "Is that what you mean?"

Ray nodded. He had the galley's main monitor tilted so that Rokey could see it from where he lay stretched out across the galley bench. Rokey was on his way to being drunk, his first response to such an emotional overload. It had calmed him down, but left him with some dreadful conclusions to ponder nonetheless. Ray pointed to a line of figures rising up gracefully across colored lines. "Magshielding locks everything inside, so when the ship is riding inside the Intraspace slip, nothing gets out—nothing. Sonic energy is absorbed as heat because it can't leak out anywhere. Luxonics systems in the ship's hull turn that sonic energy into intra-ship communications. A ship can't run on laughter and music, but it does provide some energy, and they make a big deal out of that. But the point is that the ship is a closed universe inside those fields."

"Because Intraspace itself drives the engines that drive the fields," Rokey added in the only solid fact he understood about Intraspace technology.

"So the energy of that low-end sonic field, radiating out from the center of the ship, and already amplified by the antigrav interfaces, just kept feeding back on itself, creating standing waves of incredible power."

"And getting bigger with every hour they were in Intraspace." Rokey felt a taste again of the terror on board the *Hoad*, the irrational grip of that massive non-sound. "At least while we were onboard, the energy could dissipate in heat radiation, yet it was still that bad. All those people, locked onboard, with absolutely no exit, and that terror growing and growing." He shuddered, his hackles now free to rise even though lying down.

While Ray was assembling data collected on board the *Narridge Hoad* into a more understandable picture of events, Rokey had done the research on sonics to find the answer that had nagged at him while walking through the haunted ship. He had found the answer at last, laid out in cold, clinical statistics, numbers on a screen attached to graphs that were a mockery of the ghostly faces, threatening presence, and overwhelming sense of wrongness that had pervaded the *Hoad*. Sonics twelve to fifteen cycles make the eyeball resonate, causing mistiness of vision and even hallucination; at another low frequency, adrenaloids are released; at another, the hypothalamus is stimulated to release the chemistry of emotion, raw non-specific, adrenaline-driven emotion; another produced auditory illusions, giddiness, dizziness, breathlessness, even blood pressure changes. But that was just textbook language that had nothing of the reality of fear and paranoia present in the actual experience of such rampant sound. The energy of the harmonics radiating from the hold had become fearsome standing waves, imperceptible but impossible to walk through unscathed. There had been no defense for the people on board during that terrible Intraspace crossing. The last one to die had obviously gone quite mad, scrawling that insane message above the dead.

"We still don't know where the sound came from," Rokey said finally. "And we don't know how the Urkaz got locked in there from the inside."

"We're locked in here with them now," Ray pointed out. He had turned from the screen and was looking down

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at Rokey's upturned face. "You told them we'd take them back to Urk."

"Well, I did that, didn't I?" Rokey said. His expression showed his sudden discomfort at the thought. "Why didn't you point all this out before we jumped through the window for Urk? We have jumped already, haven't we?"

"Where else were we going to take them? To the Coast Guard?"

Rokey's frown deepened. "I see what you mean." He made himself sit up, pushing himself with both hands. "What was all that noise on the *Hoad* about?"

"And why did it stop?"

The Urkaz were staying in the cargo hold of the *Yankee Shadow*, not out of disrespect but because that section of the ship had the most elaborate anti-gravity control systems. The Urkaz preferred to float, having evolved in the low gravity field of a starship millennia ago.

Ray and Rokey went below to the hold to talk to the Urkaz.

"They let us fall asleep," Idalia said. Anger trembled in his voice. "They changed the environment in the hold, and we were forced into hibernation." Shrillness made the gel of his body quiver as he spoke. "They let us fall asleep! It is not our fault!"

"No one said it was," Ray repeated calmly. "We just want to know what the noise was. Where did all that heavy-duty low-end sound come from?"

"We have to protect ourselves," Rokey added. "In order to protect you, we have to know what we're up against."

"You mustn't let us fall asleep again," Idalia said urgently. The cherry eyes were wide, and his family had drawn close to him, almost melting together. "No matter what happens between now and our arrival at the window to Urk, you must make certain that we are awake!"

"It is our fault," snapped a different, more shrill voice from somewhere in the gathered mass. "If we had been able to keep awake, nothing could have happened!"

Multiple cherry eyes spun about, seeking the Urkaz who had spoken.

"We are responsible for all that death," she went on, floating a little above the mass of her family. "And that's why we are running away now, running away and hiding."

Ray interrupted with a soothing tone that surprised even Rokey. "No one is running away from anything, ma'am. We are taking you back to your home system so that your own authorities can be brought in to investigate this, and to protect you. The *Narridge Hoad* is listed as 'vanished in transit' and her last official posting was a long, long way from where we found you. That means this was done *to* you, ma'am, not *by* you. We just don't want to let it happen here, but we have to know *what* happened. Why is it so dangerous for you to fall asleep?"

There was a long pause in which the floating cherry eyes regarded one another silently, agreed with some gelled gesture, and turned to Idalia to let him explain.

"Because when we sleep," Idalia said, eyes on his family and not the men as he spoke, "we have an instinctive defense mechanism that we cannot shut off."

"You can't kill in your sleep, can you?" Ray said in protest.

"No," Idalia said sadly. "No, but we snore. We snore loud. Really, really loud."■

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Violent Stars, Phyllis Gotlieb, TOR, $23.95, 284 pp. (ISBN: 0-312-86953-3).

The Dragon's Eye, Joel Champetier, TOR, $23.95, 301 pp. (ISBN: 0-312-86882-0).

Dog Eat Dog, Jerry Jay Carroll, Ace, $12, 295 pp. (ISBN: 0-441-00597-7).

Timberjak, Don DeBrandt, Ace, $5.99, 370 pp. (ISBN: 0-441-00626-4).

Operation Luna, Poul Anderson, TOR, $22.95, 316 pp. (ISBN: 0-312-86706-9).

Plan B, Sharon Lee and Steve Miller, Meisha Merlin (P. O. Box 7, Decatur, GA 30031), $14, 335 pp. (ISBN: 1-892065-00-2).

Sex and Violence in Zero-G, Allen Steele, Meisha Merlin (P. O. Box 7, Decatur, GA 30031), $16, 431 pp. (ISBN: 0-9658345-9-X).

The Essential Hal Clement, Volume 1: Trio for Slide Rule & Typewriter, Mark L. Olson and Anthony R. Lewis, eds., NESFA Press (P. O. Box 809, Framingham, MA 01701), $25, 523 pp. (ISBN:1-886778-06-X).

The Compleat Boucher: The Complete Short Science Fiction and Fantasy of Anthony Boucher, James A. Mann, ed., NESFA Press (P. O. Box 809, Framingham, MA 01701), $25, 532 + x pp. (ISBN:1-886778-02-7).

The Technology of Orgasm: "Hysteria," the Vibrator, and Women's Sexual Satisfaction, Rachel P. Maines, Johns Hopkins University Press, $22, 184 + xx pp. (ISBN: 0-8018-5941-7).

Phyllis Gotlieb's **Violent Stars** is the sequel to her *Flesh and Gold* (reviewed here in May 1998), at the end of which the criminal organization known as Zamos had had a serious monkey wrench tossed into their system of brothels, casinos, and genetically engineered slaves. Zamos is on trial now, with long processions of dinosauroid Khagodis, humans, amoeboid Lyhhrt (superlative bio and mechanical engineers long enslaved by the evil, insectile Ix), and others.

Now meet Tom Bullivant, Terran Ambassador to Khagodis, just arrived with Verona, the daughter of his late wife. The wife, long ago, was kidnapped and tormented. Bully married her, knowing she was pregnant, and watched helplessly as she spiraled downward into madness. Now it is Verona's turn, for there she is, safe in her room on Khagodis, when an Ix breaks through the roof and carries her off. The message for her father is: "We have lost the bitch but we have the whelp. If you do not stop prosecuting and persecuting our people the whelp will suffer nine powers of six times what the bitch did."

Zamos and Ix, allied evils bestriding the civilized worlds, do their utmost to stop the trial and maintain their grips. Ned Gattes, hero of the last book, has been summoned to aid the trial; now he must rescue Verona. Skerow, the Khagodis judge we met before, must shield her against Ix rapacity, while Hasso, child of Skerow's late lover, uses his talents as a master of archives to unearth

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disturbing links between Verona, her mother, and Zamos.

And so it goes. This is an active, violent, exciting tale of conspiracies and schemes, and a very satisfactory conclusion to what began in *Flesh and Gold*.

Enjoy!

French-Canadian Joel Champetier's **The Dragon's Eye** appeared in French in 1991. Now Jean-Louis Trudel has translated it into English, and TOR is offering it to the American market with a blurb calling Champetier "a stunning new talent."

Some of that's hype, of course. Champetier's better than many, maybe even better than most, but my socks stayed on. *Eye* is set on the distant colony world of New China, most of which was turned over to the Chinese for colonization. An island enclave was retained by Earth's dominant European-Japanese economy, which had backed the colonization effort with many gigabucks. Here are based the military forces meant to ensure repayment of the debt and a number of secret agent groups keeping eyes on each other and the New Chinese, who are rebuilding ancient China and muttering about declaring independence from Earth and repudiating their massive debt. The echoes of Earth's own China, flanked by European outposts at Hong Kong and Macao, is surely deliberate. Today's reader may think of China's recent reassertion of hegemony over Hong Kong, but there are earlier parallels as well.

At any rate, Earth wants to know what is going on. Thus the latest ship brings Commander Wang Zhong, on a secret mission, and Réjean Tanner, new man for the local European Bureau. Alas, an apparent assassination attempt on the New Chinese head honcho puts Wang in the hospital. Tanner inherits the mission: infiltrate the mainland, find the mole in the New Chinese government, who has gone unaccountably silent, and bring him back for debriefing.

And now begins the magical mystery tour through a China that might once have been, reborn on a strange new world flooded with ultraviolet by a green binary known as the Eye of the Dragon, and peopled by ordinary folks busily adapting and learning to thrive. There's plenty of local color, the characters are satisfying, and the games Champetier plays with our own history are interesting. The book is a clear success, and you'll surely enjoy it.

But to call it stunning seems a bit of a stretch.

Jerry Jay Carroll made a hit with *Top Dog*, in which Wall Street takeover shark Bogey Ingersol was magicked into another world to help Satan's local minion, Zalzathar, stomp the Forces of Good. Zalzathar had been trying for someone else, Bernie Soderberg, an even more kindred spirit, but Bogey was what he got—in the form of a dog who, in due time, switched to the side of the angels. Zalzathar lost even though Satan himself got into the act to help. Bogey went home, and his body woke up from its coma.

And he was a changed man. He served his time, lost weight, quit ripping off widows and orphans, and moved to California to take in stray dogs and give his money away. But it's a **Dog Eat Dog** world. Soderberg seems to have changed too—he's lining up for a run at the White House, he's spending money on consultants like it was popcorn, news photos show a Mr. Dark who looks a lot like Zalzathar whispering in his ear, and Pig Faces (Zalzathar's shock troops in the other world) are slaughtering Bogey's neighbors.

What's a reformed wolf to do but go to psychiatrist Alex Epperly, who thinks Bogey's story is classically delusional, just dreams from a coma, until he shows up on her doorstep as a chihuahua and enlists her in the battle to save the Earth with the aid of an angel or two, a lawyer of flexible ethic$, a private security

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agency, and a political consultant with a knack for some hilarious dirty tricks. The end is never, of course, in doubt, but Carroll gives you your money's worth of entertainment on the way.

Enjoy.

When I reviewed Don DeBrandt's *Steeldriver* a year ago, I said that anyone who enjoys Mike Resnick's use of tall tales in SF should have fun with it. That novel used the myth of John Henry, the steel-drivin' man, and wound up saying that the eternal struggle is to escape not the bonds of the machine, but the bonds of the machine's masters, the human monsters whose drive is to enslave their fellows.

In **Timberjak**—starring Paul Banyan and his sidekick Bob the blue Shinnkarien Ox—DeBrandt tackles environmental protection. The survivors of the previous tale—Hone, the cyber-enhanced "repo man" who killed Jon Hundred; Mike, who now has no body and dwells in hyperspace; Melody, an AI; and a stowaway Toolie—have been fleeing a fleet of Manticores, death machines sent to destroy the traitor Hone. Now they have reached Shinnkaria, whose forests yield a wood that generates force fields and is essential to interstellar travel. Part of the forest is the Indigo Wild, where both minds and electronics stop working and assorted nasty beasts defend the premises. So does Johnny Rainforest, who wants Paul Banyan's logging operation shut down and sends those nasties to make his point. There's also a slimeball lawyer who wants to set up a corporate takeover and shave the planet bald.

Among the things driving Johnny are the knowledge that Paul has been upping production and the suspicion that Paul is a planet-shaver. Paul, however, has a different agenda, and when our Manticore-bait heroes show up, he hires them to stop Johnny. They succeed, of course, but they also discover that alien technologies underlie the planet's peculiarities, save the planet itself, remove the lawyer from the scene, rehabilitate the misguided environmentalist, and come up with a quite dreadful terminal pun.

A nice action story that gains a nice degree of added charm because it reminds us of a childhood favorite.

Ginny Greylock and Steve Matuchek are back in Poul Anderson's **Operation Luna**, the sequel to *Operation Chaos* (1971). She's a witch, and he's a werewolf and a spacecraft engineer who works with "goetic" (magical) instead of electronic forces. That is, here's a classic *Unknown*-type blend of magic and rationalism, a world drawn to seem as parallel as possible to our own, with many a sly dig and witty reminder. The situation is this: Faerie has apparently moved to the Moon, and the U.S., using a spacecraft scientists acquired after war with the Caliphate (instead of Germany), is constructing an Apollo equivalent. Alas, despite a profusion of magical protections, it malfunctions shortly after launch and it quickly emerges that malign forces are at work.

With the NASA (National Astral Spellcraft Administration) effort dead, any future trips to the Moon must be up to Steve's own low-budget *Operation Luna*. He gains the assistance of Fjalar, a Norwegian dwarf, and soon has a high-tech broom, as lean and mean as a home-built jet. But the forces of evil have winded him, and he and Ginny, with the help of a Zuni Priest of the Bow and Fjalar, must fight off the diabolical taxman, cleanse the soul of Ginny's brother, rescue a child trapped on a one-way voyage to the Oort Cloud, and save the Fair Folk from the demons.

If you recall the earlier novel, this is a suitable sequel, every bit as satisfying as one expects from the master.

Stephen Pagel's Meisha Merlin Publishing looks like a winning operation. It's still small, but it has a nice roster of

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authors, the titles in hand look like winners, and Pagel's table in the Boskone dealer room was quite busy.

Sharon Lee's and Steve Miller's **Plan B** is the long awaited continuation of their Liaden Universe series, which began in the late eighties with *Conflict of Honors*, *Agent of Change*, and *Carpe Diem* (reviewed here in April 1990). The publisher dropped the series just as it hovered on the cusp of great developments, and for a decade Liaden fans have pestered Sharon and Steve for more. Happily, they have found another publisher in Meisha Merlin, who plans to reissue the earlier books in the omnibus volume *Partners in Necessity*; there will also be other books.

Liaden is a world organized by clans, one of which is Korval, quirky and independent enough to be a special target for destruction by the nefarious Department of the Interior, which once had Val Con yos'Phelium thoroughly under its thumb. Fortunately, Val Con got loose, together with his lifemate Miri. Clan Korval decided it was under attack and it was time to put the long-plotted "Plan B" into action, meaning to disperse and hunker while Val Con's brother Shan arms his merchant ship, and Val Con and Miri visit the world of Lytaxin to nail down her identity as a long-lost scion of Erob, a clan long and intimately allied with Korval. Of course, while they're there, the Yxtrang (something like a horde of giant Mongols or wild Dorsai) attack Lytaxin and must be resisted until all the various friends and relations of Val Con and Miri can converge on the battle zone to bestow whatever *coup de grace* remains unbestowed.

When I reviewed *Carpe Diem*, I had both praise and reservations. The latter centered in part on a certain murkiness owing to the tale's dependence on preceding volumes. The dependence remains, but the murkiness is gone. Sharon and Steve used their time between publishers to good advantage, honing this one into an exciting romp that promises their fans a great deal of fun with future volumes.

Allen Steele's **Sex and Violence in Zero-G** collects all of his "Near-Space" stories except "Red Planet Blues," including "The Weight," a novella previously published only by England's Legend and reviewed here in August 1996 ("it centers on the voyage of the *Medici Explorer*, a deep-space shepherd for a convoy of automated freighters, from lunar orbit to Jupiter, where it will pick up a shipment of Helium-3 for Earth's fusion power plants. . . . quite descriptive of the ship, its procedures, and its crew—an 'extended family' of a sort Heinlein would have liked. For drama, Steele tosses in a bit of resentment of media interest in the family's sex life, the rescue of a marooned space-wreck survivor, and an insurrection at the Helium-3 depot. The overall effect is thoughtful but light. . ."). There are also a few new items, including "0.0G Sex: A User's Guide" (instructions for use of the fornicatorium on a deep space liner), a "Near-Space Timeline," and sketches of ships and space stations.

A "must-have" for Steele fans.

Last February 22, the Science Fiction and Fantasy Writers of America (SFWA) announced their choice of Hal Clement (Harry Clement Stubbs) for the 1998 Grand Master award, representing "the pinnacle of peer recognition in the genres of science fiction and fantasy." This award is given "by SFWA in recognition of a lifetime of achievement in science fiction and/or fantasy writing. . . . Previous Grand Masters include Robert A. Heinlein (1974), Jack Williamson (1975), Clifford D. Simak (1976), L. Sprague de Camp (1978), Fritz Leiber (1981), Andre Norton (1983), Arthur C. Clarke (1985), Isaac Asimov (1986), Alfred Bester (1987), Ray Bradbury (1988), Lester del Rey (1990), Frederik Pohl (1992), Damon Knight (1994), A. E. van Vogt (1995), Jack Vance (1996), and Poul Anderson

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(1997)." Hal began his career with an *Astounding* short story ("Proof") in 1946 and went on to write seminal works of hard SF such as *Mission of Gravity*, which "typifies Clement's imaginative creation of scientifically plausible but truly weird worlds, a recurring theme of his work. A clean, spare writer with an ability to dramatize complex scientific ideas in a compelling way, Clement invariably leaves the reader with the sense that the universe is a fascinating and wonderful place—and the laws that govern its behavior are equally fascinating and wonderful. Consequently, his work has influenced and inspired a whole generation of scientists and engineers as well as a whole generation of writers." [quotations from the SFWA press release]

If you think that sounds like so much nostalgic hype, you're too young to remember Hal and his work. You should therefore get on the stick and immediately order a copy of **The Essential Hal Clement, Volume 1: Trio for Slide Rule & Typewriter**, which includes the novels *Needle* (1949) (symbiotes as cops and robbers), *Iceworld* (1951) (heat-lovers visit Earth), and *Close to Critical* (1958) (survival in question on a high-gravity, high-pressure world), all once *Astounding* serials and still eminently readable.

If you're familiar with Hal's work and know that press release tells it true, you will be delighted to know that NESFA plans two more attractive hardbounds to replace those ratty old paperbacks on your bookshelves.

NESFA also brings us **The Compleat Boucher: The Complete Short Science Fiction and Fantasy of Anthony Boucher**. Boucher, whose real name was William Anthony Parker White, was the co-founder of *The Magazine of Fantasy & Science Fiction* way back in 1949, was a well-known mystery writer, edited popular SF anthologies, and in the 1940s wrote a great deal of SF&F for *Unknown Worlds* and *Astounding*.

You'll find the stories—forty-five of them—here, beginning with the one editor Jim Mann calls his best, "The Quest for Saint Aquin." Many are short, witty, and as readable as ever even if styles have changed in the last half-century. One item is particularly tasty: Boucher was also a critic, opera fan, and gourmet chef, and to prove that last, Mann caps the book with his "Recipe for Curry De Luxe."

It's technology, this is a science fiction magazine, and *Library Journal's* review said, "This fascinating and exquisitely referenced true story reads like twisted science fiction," so please bear with me as I tell you about Rachel P. Maines's **The Technology of Orgasm: "Hysteria," the Vibrator, and Women's Sexual Satisfaction**, no matter how vigorously your eyebrows are denting the ceiling.

First, the preface is a hoot and a half, for the author displays a very nice sense of humor as she recounts the receptions her talks and papers on her book's topic have received.

Second, the book is quite serious and extraordinarily illuminating and thought-provoking. Maines tells us that "hysteria" is an ancient ailment whose symptoms have occasionally been recognized as those of sexual excitement unrelieved by orgasm. Our culture has long focused on the "androgenic model" of sexuality, meaning penetration and male orgasm, and assumed that what satisfies *him* should certainly satisfy *her*, despite data showing that "androgenic" sex leaves most women high and dry. Her resulting condition has been defined by male doctors as an illness. The treatment was pelvic massage, generally by hand. Treatment was an office-visit cash cow for physicians, and despite the prurient giggle the idea may arouse in us today, few of those physicians seemed to find much thrill in it. Indeed, stimulating female patients to relief of their symptoms of orgasmic deprivation was "the job no-

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body wanted"; physicians palmed it off on interns and midwives, and when technology produced substitutes for the hand, they welcomed it.

In the nineteenth century, one popular technology was hydrotherapy, meaning the use of water under pressure—douches and hoses—to vibrate the pelvic tissues. The major problem with it was apparently keeping the patients from overindulging.

Other techniques included steam-powered massagers and electrically powered vibrators, some of which looked Rube-Goldbergy enough to scare a modern into orgasmic incapability. The mechanisms quickly shrank in size, and when they appeared in stag films such as "Widow's Delight" in the 1920s, they stopped appearing in physicians' offices. Instead, they went home, with even Sears, Roebuck advertising "Aids That Every Woman Appreciates" (the attachments included a mixer and a fan, among other things).

Maines has a good deal to say about the "medicalization" of women's sexuality, male blindness or obtuseness (which by her account is quite phenomenal) and selfishness, and "social camouflage," which means the immense unconscious effort we can go to to keep from calling a spade a spade, or a vibrator an orgasm-producer. In the twenties, she says, the camouflage was ruptured. Advertising to both the medical and home markets vanished, for the undisguised vibrator was no longer respectable. By the sixties, however, "the modern vibrator [had] resurfaced . . . as a frankly sexual toy. . . [and] few efforts were made to camouflage its sexual benefits."

At least until 1998, when Alabama banned the sale of "sex toys," notably including vibrators, as part of its effort to eliminate sex shops (the penalty if caught is a $10,000 fine and a year of hard labor). As I was reading Maines's book, the news that week was that the American Civil Liberties Union and a number of local women were asking a federal court to strike the state law down as unconstitutional.

And the camouflage remains intact: Even in Alabama, you can pop down to Wal-Mart and pick one up—the label says it's for massage and muscle relaxation, and the picture on the box shows it held against the side of a lovely lady's neck.

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BRASS TACKS

Dr. Schmidt:

I always enjoy reading your magazine. The stories and articles are interesting in and of themselves. The April 1999 edition, however, presented me with something a little deeper.

Let's start with "Remembrance of Things To Come." This story initially struck a chord with me, as it meshed with my personal philosophy that time travel cannot change history. If you travel into the past, whatever you will already have done, and is/will be part of the history which brings you to the point where you traveled back in time.

A little later I read "Democritus' Violin." About four-fifths of the way through the story I came across a misspelling of one characters' last name. It was misspelled "Stephen's" instead of "Stevens." A few paragraphs later the name was again misspelled "Stephens." I flashed back to the main plot point of "Remembrance"—the "typo" of W and S. Although the misspelling of the name had no apparent effect on the meaning of the story, it was an interesting coincidence.

Then there was Tom Easton's review of "Standing Wave." At one point, Mr. Easton expounds, "Wow! Great stuff—at least, if you're into 'shrooms and mental powers and such . . ." and I thought, wow, this is almost the same way I felt about the story, "Going Home." Here is a story about people who use Faster Than Light (FTL) travel to go to a distant solar system and return to Earth, but become virtual zombies because of some claptrap about not being able to communicate FTL and "Nature's inflexible timeline for information." Their bodies and their minds and memories can travel FTL, but some cosmic power dictates that they can't tell what they have seen because the information would not get to earth for another 11.8 years at the speed of light? And even if we accept that ridiculous premise, wouldn't it be 23.6 years (11.8 years out and 11.8 years back)? And I thought, "Wow! Great stuff—at least if you're into pseudo-psychic-mystical-new-age philosophy BS."

Maybe I just don't get it, but I think a story should at the very least try to present some logical basis for a point which is the linchpin of the entire plot.

Edwin Frydendall

There's a reason why "Going Home" was listed as "Probability Zero"! Stories under that heading are usually jokes, on one or more levels; e.g., they look plausible until you notice a subtle but crucial flaw in the premise or logic. This one depended on taking literally something we're often told about the lightspeed limitation. Sorry it didn't work for you.

Hello Stan:

I want to bring up a question that came to mind at the conclusion of "Democritus' Violin." I'm not a physicist, nor do I play one on TV, but it seems to me that from my rudimentary understanding of the carbon-14 dating technique (certain naturally occurring carbon isotopes decay at a known rate) that there is a problem with the conclusion of the story.

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Wouldn't a matter generator such as described in the story copy the object *including* the already-decayed carbon isotopes? If such a machine just used a "standard" isotope in its substitution then the atomic weights would be all off, etc. I know this is completely different, but to make an analogy, it's almost as if this machine was able to scan a document that had been faded by the sun and produce a fresh, crisp copy. I suppose this could have easily been addressed with a couple sentences regarding how the machine handled isotopes, but then that would probably have given the ending away. . . .

In any case, it was still a good story. I was expecting that the problems with the tension of the strings and the resulting necessity to eliminate a few molecular "slices" of the violin was going to have either disastrous or spectacular results. Thus, I was pleasantly surprised at the end. I enjoy *Analog* immensely—keep up the good work!

Jim Mason

The author replies. . . .

Thanks for your kind words on my story.

The matter replicator in question was not intended to be a matter generator, but rather a nanotechnology application that places atoms and molecules from some external supply individually in the correct places. It would use, unless someone was really ahead of the game (or read my story first!) the isotope ratios in the ambient atmosphere, which would be different than that of 300 year-old wood. This minor difference on the nuclear level of a tiny fraction of the violin's carbon atoms would not much affect the performance of the violin on the atomic level; the carbon is still carbon. The difference would, in fact, require sensitive instruments to detect.

You got me thinking, however. If I had them duplicate a water xylophone (glasses of water at just the right level to produce the desired pitch when struck) wherein someone had used heavy water exclusively—water in which each water molecule has two deuterons and weighs 20/18 what ordinary water weighs—and replaced it with said ordinary light water, the pitch difference would probably be detectable by an educated ear. I might try to work that into a "Singing Bell" type detective story some day. Thanks for the idea.

Gerald "G. David" Nordley

Dear Dr. Schmidt,

I enjoyed your editorial, "Rights vs. Rightness," in the April issue. The central problem is a tough one. If we restrict, let's say voting, only to those who are well-informed, we theoretically elect better leaders and legislators, to everyone's benefit. Unfortunately, we'd also be telling many people, "we're going to make the decisions for you, whether you like it or not, and you don't have anything to say about it." That's tyranny. If we're lucky, it would be benevolent tyranny, but I have serious doubts that any form of tyranny can remain benevolent in the long run.

Another point to ponder—voter turnout tends to be very low in the United States. It would be very interesting to determine the correlation, if any, between the tendency to vote and the tendency to be informed. If it turned out that the informed tend to vote and the uninformed tend not to, then things aren't that bad after all. (Of course, that might be wishful thinking. For all I know, the opposite could be true, or maybe there's no correlation.)

I found it curious that you described as a "somewhat peculiar meritocracy," a system in which any citizen who passes a test earns the right to vote.

I was not aware that the concept of meritocracy involved closing off access to the ruling class, or that such a class must necessarily be small. Indeed, I thought social mobility was an integral part, if not one of the main points, of a meritocracy. People who show merit,

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however that might be measured, get to rise in the hierarchy. (In theory, this should also mean that incompetence lowers one's position.)

David Cederstrom

Dear Stan,

I agree with you that the only way to have a (for lack of a better phrase) representative meritocracy is to have an informed, interested electorate, but we also need informed, interested people to represent that electorate. Living and working in the Washington, DC area, I get a close-up look at our government in action. Unfortunately, most of them are passing laws on subjects they have no knowledge of whatsoever, and many of them freely admit that they seldom bother to actually read the laws they're voting on. (Of course, given that some of them consist of three or four hundred pages of legalese, it's hard to blame them!) Perhaps once we succeed in educating the voters, we'll have candidates who are informed enough to have at least some knowledge of the subjects they're voting on and interested enough to see past winning the next election, to what's best for the country they're governing. Based on what I've seen in the past few years, I'm not holding my breath, though.

Amy E. Baggott

Dear Dr. Schmidt,

Your April 1999 editorial ("Rights vs. Rightness") discusses the inherent conflict between the expertise needed for complex decisions and the need for including all those effected by the decision. After pointing out the two primary alternatives—meritocracy with the potential for abuse of power, and equality with mediocrity—you ask "is there a way we can guard against both?" You then make a cogent argument for public education and an "informed, interested electorate" as the only alternative.

While, in principle, I agree with you (and Thomas Jefferson), there are other alternatives that we can use today—while we wait for a future of universal enlightenment.

Since the 1980s, the Danish government has used "Citizens' Panels" to address complex technological issues. These panels are a cross between a jury system and a town meeting. In essence, a group of laypeople are chosen to focus on the issue in question, then brought up to speed on the issues before deliberating on them. The entire process is run in public view. Like the jury system, the process relies on having a small group of representative citizens take the time to deal with an issue in depth—relying on visibility to keep everybody honest.

While perhaps not the perfect, or only, approach, Citizens' Panels seem to be working for the Danes, and have also found some acceptance in the European community. A few experiments have been tried in the U.S. as well.

Again, while I agree that we need to advance the causes of education and reason as broad societal goals—we need not wait before also addressing the pressing issues of our times.

Miles Fidelman

P.S. A good source of information on Citizens' Panels is the Loka Institute's web site, at www.loka.org, which includes references to additional sources.

Dr. Schmidt,

I have been a subscriber to *Analog* for eleven years, and my favorite part of the magazine is your editorials. "A Voice of Reason . . . ," etc. I work for CTB/McGraw-Hill, a national school test publisher in California, and have been trying for years to get one of your editorials into a test (no luck yet, but you certainly know the public school system in this country). I would like to say that I completely agree with your editorial on "Right vs. Rightness" if I'm to understand that your suggested solution to the choice between government by an "Informed Minority" and an "Ignorant Majority" is to

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educate the public via improving public education. I was just wondering if a third alternative might be more expedient . . . couldn't we (or Congress or somebody) just pass some laws that required our elected representatives to have some basic grounding in the sciences (math, chemistry, physics, medicine, ecology, you get the point . . .) like any graduate of a junior college would have? It certainly would be cheaper than putting money into public education. Not as good an idea as yours, and Washington would never go for it, anyway, but I wanted to throw it out there.

David Lewis

Dear Dr. Schmidt,

Regarding your April 1999 editorial, I agree almost entirely with your conclusion that an informed, interested electorate is essential for the safe running of society. However, education does not guarantee good decision-making. We all likely know at least one Ph.D. whose views on some subject are demonstably false. Society is full of people who may be avid learners but do not have the tools to distinguish the plausible from the outlandish. What's needed is not merely a strong public education system, but one in which critical thinking is taught and tested. Skepticism, not merely smarts, ought to be the standard for the electorate.

A strong public education system is *one in which critical thinking is taught. And a good starting point might be to try to make everyone understand the difference between schooling and education—either of which can, and often does, happen without the other!*

Dear Dr. Schmidt,

Jeffery Kooistra's two-part Alternate View article in your February and April 1999 magazines was thought provoking. It is articles like this, coupled with such fine science fiction and editorials, which makes your magazine such an enjoyment to read.

Concerning Mr. Kooistra's problem with the Warlock Wheel and its apparent "spooky behavior," there are a few physicists who would be glad to explain "just what" the ring and torus are pushing against to make them both turn in the same direction. There are others who, for fear of committing career suicide, will only admit it to themselves.

Their answer is that the ring and torus are pushing against the ether. And no, they aren't the recipients of all that grass Jeffery was cutting. Without detailing the numerous pieces of evidence in favor of the ether (but it would make an interesting Alternate View article), I would like to quote from an article in the March 1999 issue of Scientific American titled "A Little Big Bang" by Madhusree Mukerjee. On page sixty-one appears the following: "Theorists also believe that seemingly empty space—the unaptly named vacuum—is in actuality teeming with quark-antiquark pairs, which make their presence known only indirectly." The article did not put a name to the "vacuum filled with quark-antiquark pairs," but isn't this the definition of the ether?

Carl Brubaker

Dear Stan,

After reading Jeffery D. Kooistra's second article on this subject, I seriously wonder if he ever stopped in a university and asked a couple of the professors instead of the students.

It doesn't take much insight to notice that when the leads going to the ring and the magnets are rotated by 90 degrees, the system is at a much lower energy state. At that point in time, the magnetic field from current passing through the wire will cancel the magnetic field from each of the magnets respectively.

Once one realizes there is an energy difference between the two states, they should also realize there is a force to

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move the ring from one state to the other. Even if the wires are not attached to the ring, but instead use brush contacts so they can remain fixed as Jeffrey describes, this force still exists.

There is no mystery as to why the motor spins. Even someone with an introductory course from Halliday and Resnik can tell you that. The only interesting part is finding out if the calculations one can make with textbooks like Wiley's *Classical Electrical Dynamics* determine the correct rate of spin.

Now, as to the latest results where he gets it to "spin" the wrong way, his explanation was not very clear, but it sounds like he was saying the magnets end up spinning the same way as the ring? If so, that is interesting. There are two places I can think of to look for the momentum in the opposite direction. The first, and most likely would be from the base the magnets are mounted on. The coefficient of kinetic friction is less than that of static friction. So, if the motion is jerky it is possible for it to transfer momentum and end up moving the wrong way. The second possibility would be that the momentum is carried away by the electric magnetic field. As you probably know, photons have a spin of 1, so quite often electromagnetic fields are used to slow rotating systems. I haven't heard of a motor that is actually made to rotate faster by the same effect, but it is possible. Since I don't know how much current is used, the masses involved, etc. I can't really say if this is a realistic possibility.

Bill C. Riemers

The author replies. . . .

Leaving aside the disparaging comments about asking professors instead of students (since I have been a professor and have taught from Halliday & Resnick, and since most of my co-workers on this actually have doctorates in physics), I'll just get to the relevant points.

The comments about the torus to a lower energy state are axiomatic—everyone notices that almost immediately. The question is whether or not this will happen with a suspended torus in the field-free condition, and that is not covered in H&R, nor almost anywhere else. Another question is whether or not this has anything to do with what the ring will do.

As for the ring rotation, I am well aware of the nature of jerky movements, etc. The magnet pair was suspended from a thin monofilament line attached to the ceiling. The ring was attached to a Styrofoam cup and also suspended from the ceiling. I had to immerse the bulk of the magnet pair in a well of cold pancake syrup to damp its acceleration, otherwise it starts moving so fast that the ring doesn't have a chance to get started before the magnets rotate through the null position and reverse the polarities. Upon application of current, both ring and magnet pair began turning, very smoothly, in the same direction.

In short, magnet motion is a poor predictor of ring behavior.

You're welcome to your ideas on why this should happen. Everyone is welcome to think about it and now that I'm being paid to put a "Marinov Motor Kit" together, home experimenters will soon get a chance to do their own work on the motor. A kit should be available sometime this year from Cold Fusion Technology, Inc. I'll keep you posted.

Jeffery D. Kooistra□

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UPCOMING EVENTS Anthony Lewis

1–3 October 1999
ARCHON 23 (St. Louis area SF conference) at Gateway Center & Holiday Inn, Collinsville, IL. Guest of Honor—Gardner Dozois; Artist Guest of Honor—Ray Van Tillburg; TM—Forrest J Ackerman. Registration—$30 until 31 August 1999, $35 thereafter. Info—Archon 23, P.O. Box 8387, St. Louis, MO 63132-8387. URL—www.stlf.org/archon/23/index.html

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1–3 October 1999
VIABLE PARADISE III (Cape and Islands area SF conference) at Island Inn, Oak Bluffs, MA. Guest of Honor—Joe Haldeman; Artist Guest of Honor—Rick Berry; Fan Guests of Honor—Ted and Bonnie Atwood; Net Guests of Honor—James D. Macdonald and Debra Doyle. Registration—$40. Info—Martha's Vineyard SF Association, PO Box 3404, Oak Bluffs, MA 02557. Email—paradise@rmontor.tiac.net; URL—www.sff.net/paradise *or* www.tiac.net/users/rmontor/paradise

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8–11 October 1999
GAYLAXICON 1999 (SF conference for gay sf fans and their friends) at Washington, D.C. Guest of Honor—Diane Duane; Artist Guest of Honor—Nancy Janda. Registration—$50 until 8 August 1999, $60 thereafter. Info—Gaylaxicon 1999, c/o Lambda Sci-Fi, Box 656, Washington, DC 20044. (202) 232-3141. Email—gcon1999@aol.com; URL—lambdasf.org/gaylaxacon1999/index.html

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15–17 October 1999
CANVENTION 19/INCONSEQUENTIAL II (Canadian National SF convention) at Lord Beaverbrook Hotel, Fredericton (near Oromocto), N. B. Guest of Honour—Tanya Huff. Registration—C$30 until 4 October 1999, C$35 at the door. Info—Brian Davis, Canvention Liaison, 45 Charm Court, Fredericton, NB E3B 7J6 Canada. (506) 459-5758. Email—badavis@nbnet.nb.ca

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4–7 November 1999
WORLD FANTASY CONVENTION/VOYAGES at Rhode Island Convention Center, Westin Hotel, Biltmore Hotel, Providence, R.I. Guests of Honor—Patricia A. McKillip, Charles de Lint, Robert Silverberg, Leo & Diane Dillon; Special Guest—Samuel R. Delany; TM—John M. Ford. Registration—$125 (limited to 850); $35 supporting (payable to MCFI). Info—World Fantasy Convention, c/o MCFI, Box 1010, Framingham, MA 01701-1010. Fax—(617)776-3243; Email—wfc@mcfi.org; URL—http://www.mcfi.org/wfc

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31 August–4 September 2000
CHICON 2000 (58th World Science Fiction Convention) at Hyatt Regency, Chicago, Ill. Guests of Honor—Ben Bova (former editor of *Analog*), Bob Eggleton, Jim Baen, Bob & Ann Passovoy, TM—Harry Turtledove. Registration—$135; supporting $40. These are the latest posted rates as of the time this column went to press.] This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition—the works. Info—Chicon 2000, Box 642057, Chicago, IL 60664. Email—info@chicon.org; URL—www.chicon.org/ ■

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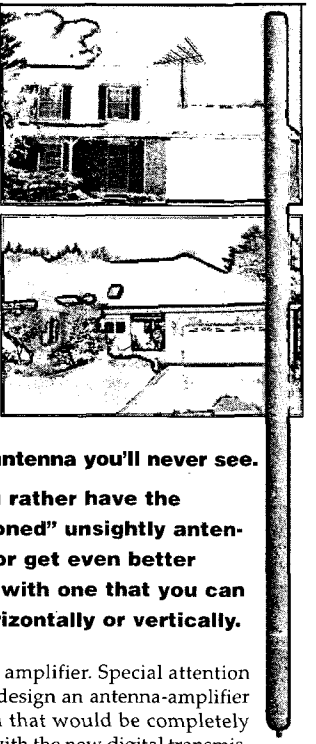
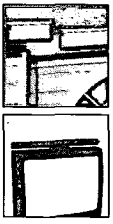
TECHNOLOGY UPDATE

Stealth antenna hides under gutters but performs like big ugly antennas

The new Max Antenna by GE is the low-profile, high-gain way to get flawless reception of broadcast signals without expensive installation.

by Hope Chapman





The Max Antenna by GE is the ultimate TV antenna system.

Electronic engineers agree—your television is only as good as the signal it receives. Unfortunately, antenna design has not kept pace with improvements in television quality and the features available. Both cable and satellite television systems have spent a great deal to improve the quality of their transmission, but they can be extremely expensive, they aren't available in all areas and may not provide access to local TV stations. Luckily, there is a new antenna from GE that will provide breakthrough performance without making your family room look like something out of the fifties.

Clear alternative. The Max Antenna series from GE uses a revolutionary electromagnetic design to maximize installation flexibility and yield longer range reception of off-air VHF and UHF signals. Unlike a conventional dipole antenna, the Max Antenna can receive signals in both vertical and horizontal planes with minimum cross-polarization loss. This design allows for the first low-profile antenna solution that provides numerous installation options.

Superior components. The key to the superiority of this antenna is its ingenious use of the latest electromagnetic technology—providing high gain and full channel coverage as well as the greatest amount of mounting flexibility. First, the antennas were designed around a wide band element to achieve the greatest amount of gain in a relatively small space. Next, an amplifier and matching network was designed to enhance the reception of weak signals. This amplifier also adds very little distortion to the strong signals, giving it a balanced amount of gain. A filter on the amplifier board will allow for good matching between the antenna and amplifier. Special attention was paid to design an antenna-amplifier combination that would be completely compatible with the new digital transmission format. It has been designed for strong signal distortion rejection and a low amount of noise. It is omnidirectional and requires no adjustments, orienting or fine tuning during use. You simply install it, set it and forget it.

Risk-free reception. The Max Antenna comes with Comtrad's exclusive risk-free home trial. If you are not completely satisfied, return it within 90 days for a full "No Questions Asked" refund.

The best antenna you'll never see.

Would you rather have the "old-fashioned" unsightly antenna tower or get even better reception with one that you can mount horizontally or vertically.

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20-mile range

Mid-range Max Antenna . . . . $69.95 $9.95 S&H
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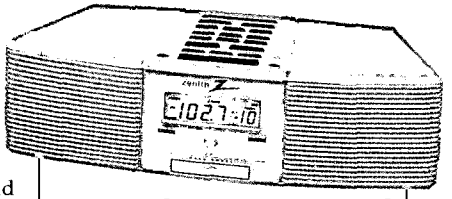
Big sound from a stereo radio—without the big price!

Zenith Audio, a leading electronics manufacturer designs a "Small Footprint," "Big Sound" stereo system and drives the price below $100.



Zenith Audio has developed a Digital Stereo Clock Radio that boasts the acoustic quality and practical features of stereo radios four times as expensive. You'll be amazed at the sound quality and powerful bass you get from a radio this small and this affordable. This stereo radio features an 11-key handheld remote control and an input jack for CD players or other audio sources.

Micro-Electronic Sound Breakthrough

State of the art stereo sound quality in a stylish cabinet

- AM/FM/TV Bands
- Stereo Speakers with Crystal Sound System
- Digital Weather Band
- 37 Preset Station Memories
- Ascending Tone Alarm
- Wake/Sleep to Radio, Weather or TV Band
- "Fail-safe" Alarm System

Loaded with features. The AM/FM radio features digital tuning for pinpoint reception and crystal-clear sound. The STEREO indicator allows you to tune in to the stereo signal. It also picks up TV and WEATHER signals with 13 TV channels and 7 Weather channels, so your Zenith Audio Clock Radio is a great source of news, entertainment and information. You can program the unit's memory for 37 preset stations, and the tuning buttons can operate either manually or in a automatic search mode.

Practical functions. The backlit clock has several alarm functions, so you can wake to either radio, TV, weather or a buzzer. The sleep timer allows you to fall asleep to up to 90 minutes of music, TV or weather and then shuts off automatically. In the morning, if you need a few extra minutes of sleep, press the SNOOZE bar on the control panel or on the remote. The radio or alarm tone stops for 10 minutes and then sounds again. The unit's battery backup system will maintain the time, alarm and preset station memories in the event of a temporary power interruption.

Factory direct risk-free offer. You can spend hundreds of dollars more on a stereo radio, but why do it? We get the Stereo Clock Radio direct from Zenith and pass the savings on to you. This product comes with a one-year manufacturer's limited warranty and Comtrad's exclusive risk-free home trial. If you are not satisfied for any reason, simply return it within 90 days for a full "No Questions Asked" refund.

Zenith Crystal Clear Stereo. .$99.95 $12 S&H

Please specify white or black.

Please mention promotional code 4242-16223

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